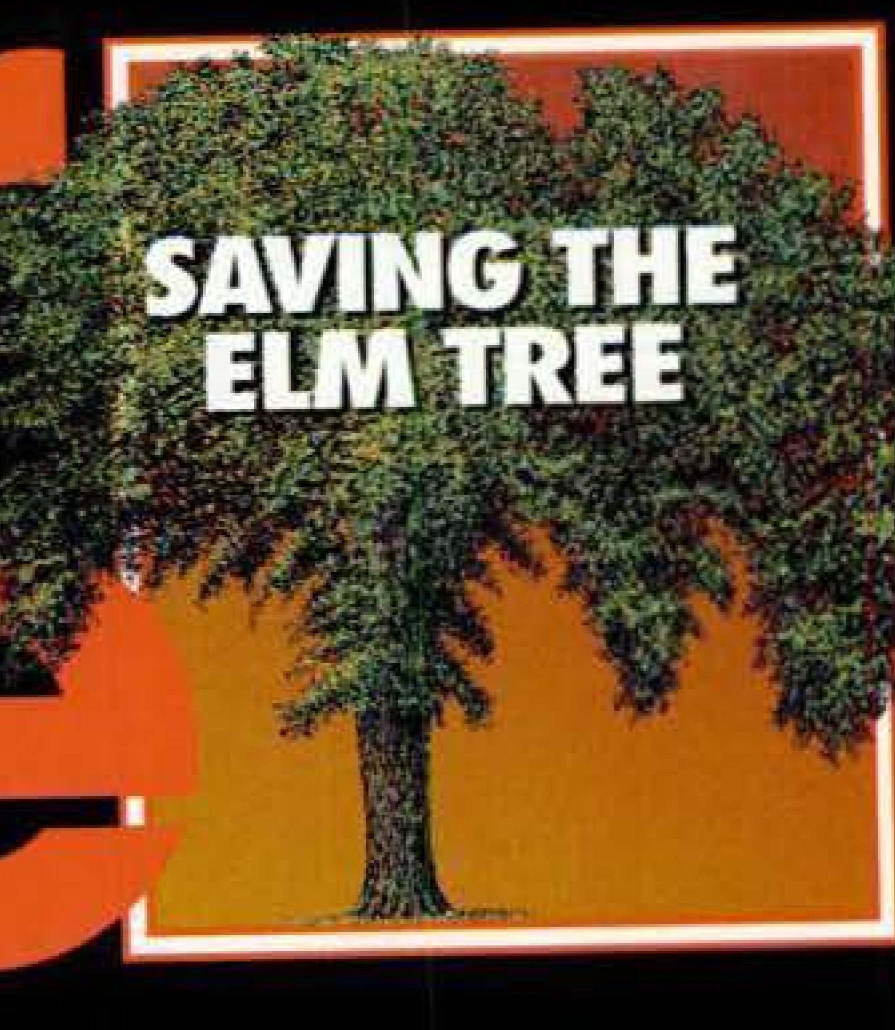
THE EXTRASENSORY CAR

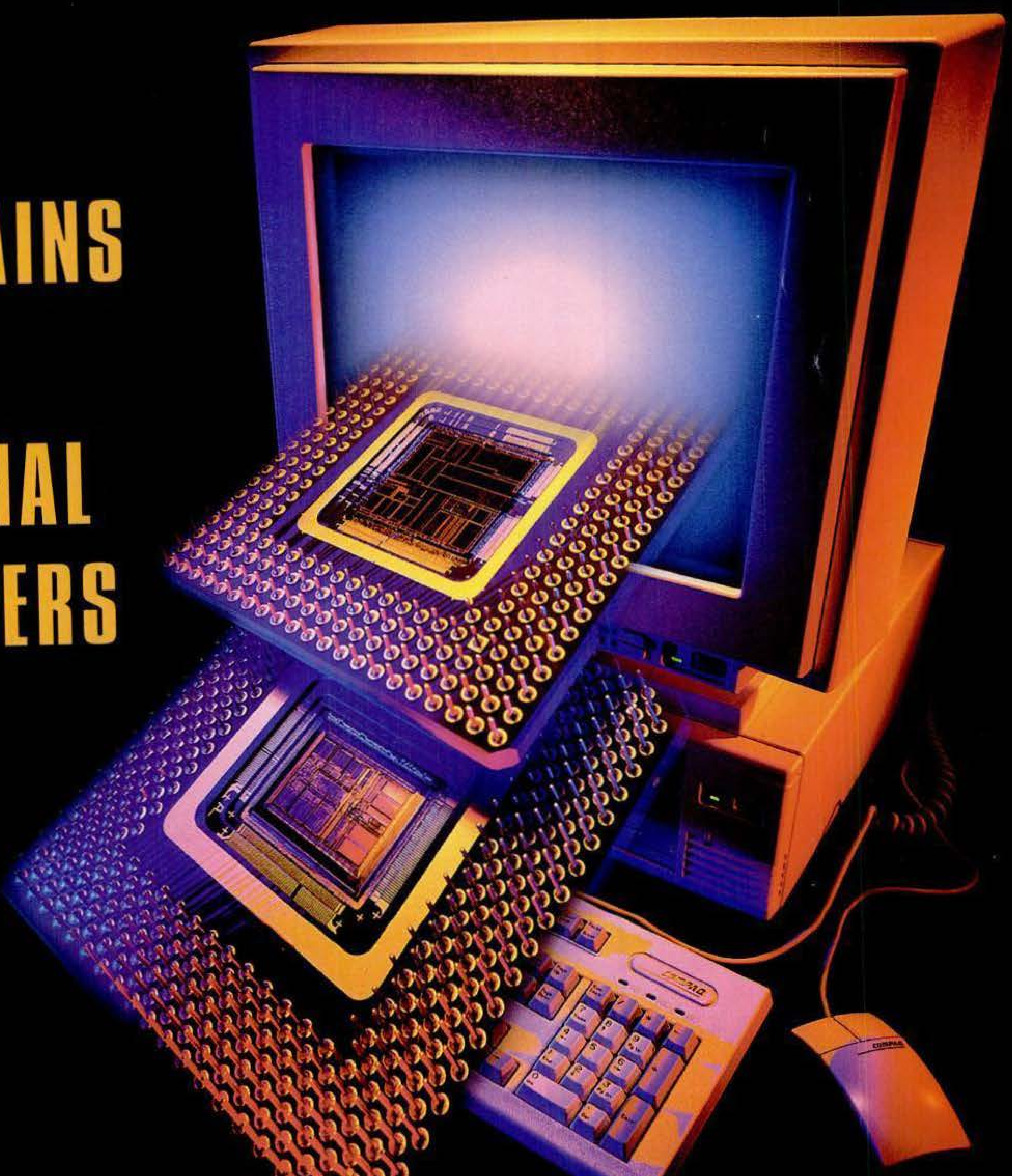
A Times Mirror Magazine

Popular Science



SAVING THE ELM TREE

NEW BRAINS *for* PERSONAL COMPUTERS



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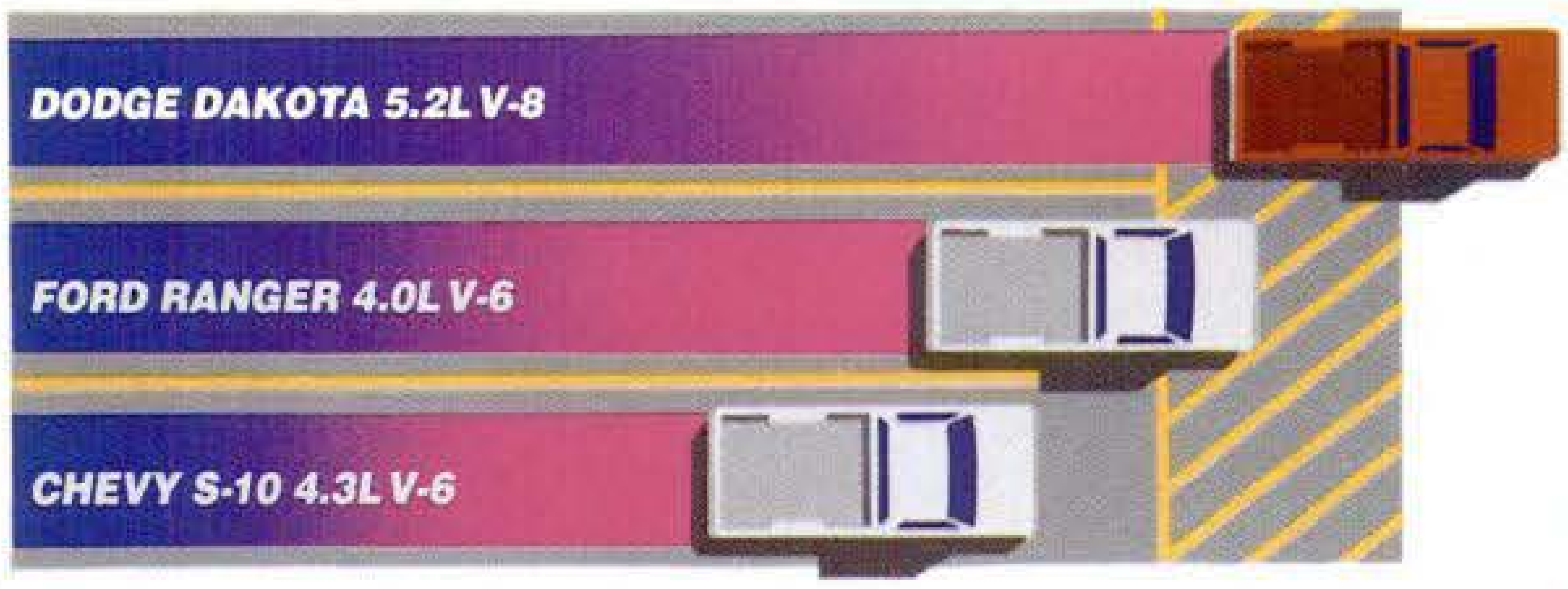
"Out-powers and Chevy and Ford compact or

Comparing a Dodge Dakota V-8 to other pickups is easy. There's simply no comparison.



Dodge Dakota 4x2 Club Cab out-runs the compact extended cabs 0-60, with 960 lbs payload and with 5,850 lbs combined payload and trailer weight.[1]

Compacts like Ranger and S-10 can't measure up. They don't have this Dakota's room. Its available payload. Its power. And certainly not its quickness off the line. We can prove it, too.

In a whole series of SCORE certified tests, a mid-size Dakota, equipped with our available 5.2L Magnum V-8, out-ran the most powerful compacts Ford or Chevy have to offer. Out-accelerating them both. With loads or without. Even when loaded up with a trailer, too.

BUY OR LEASE AT YOUR DODGE DEALER. Buckle up for safety.

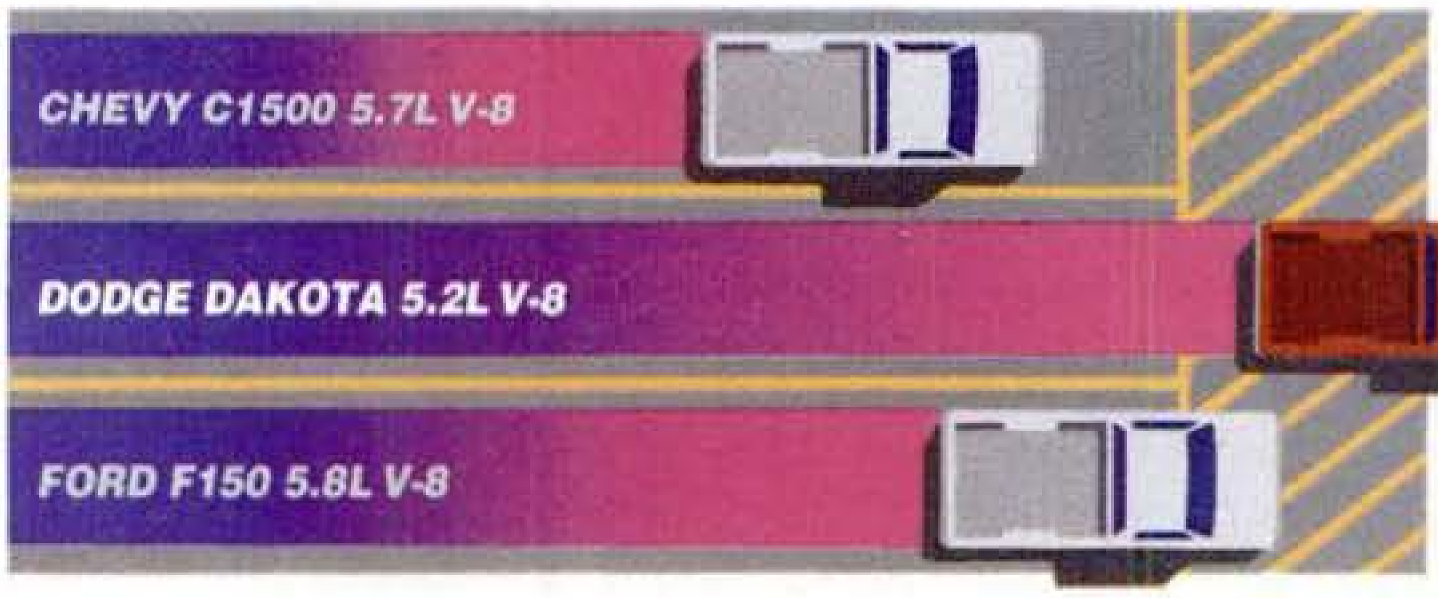
out-accelerates hands down, half-ton.”

-*Certified by SCORE International, January 1992*

With that 230 hp power plant pulling for it, Dakota over-powers *full-size* Ford and Chevy half-tons, as well. Outrunning them, empty and loaded. And delivering more horsepower and more available towing than a standard F150 or C1500 pickup.

The warranty's no contest either. Dakota is backed by a choice unmatched by any truck manufacturer, anywhere. Our exclusive Owner's Choice Protection Plan.[2]

All in all, it's one very powerful story. Just one more example of how our Magnum engines make Dodge the most powerful line of trucks you can buy.[3]



Dodge Dakota 4x2 Club Cab out-paces full-size regular cab pickups 0-60, with 1,150 lbs payload and with 6,040 lbs combined payload and trailer weight.[1]

Call 1-800-4-A-DODGE
for a free product brochure.

THE NEW DODGE
A DIVISION OF THE CHRYSLER CORPORATION

Dodge Dakota LE Club Cab
5.2L Magnum V-8

[1] All trucks equipped with auto. trans. & max. avail. axle ratios. Graphs not proportional to test data. [2] See limited warranties,
normal maintenance, adjustments & wear items. [3] Overall total scores of combined model segment comparisons. All claims & co

This One
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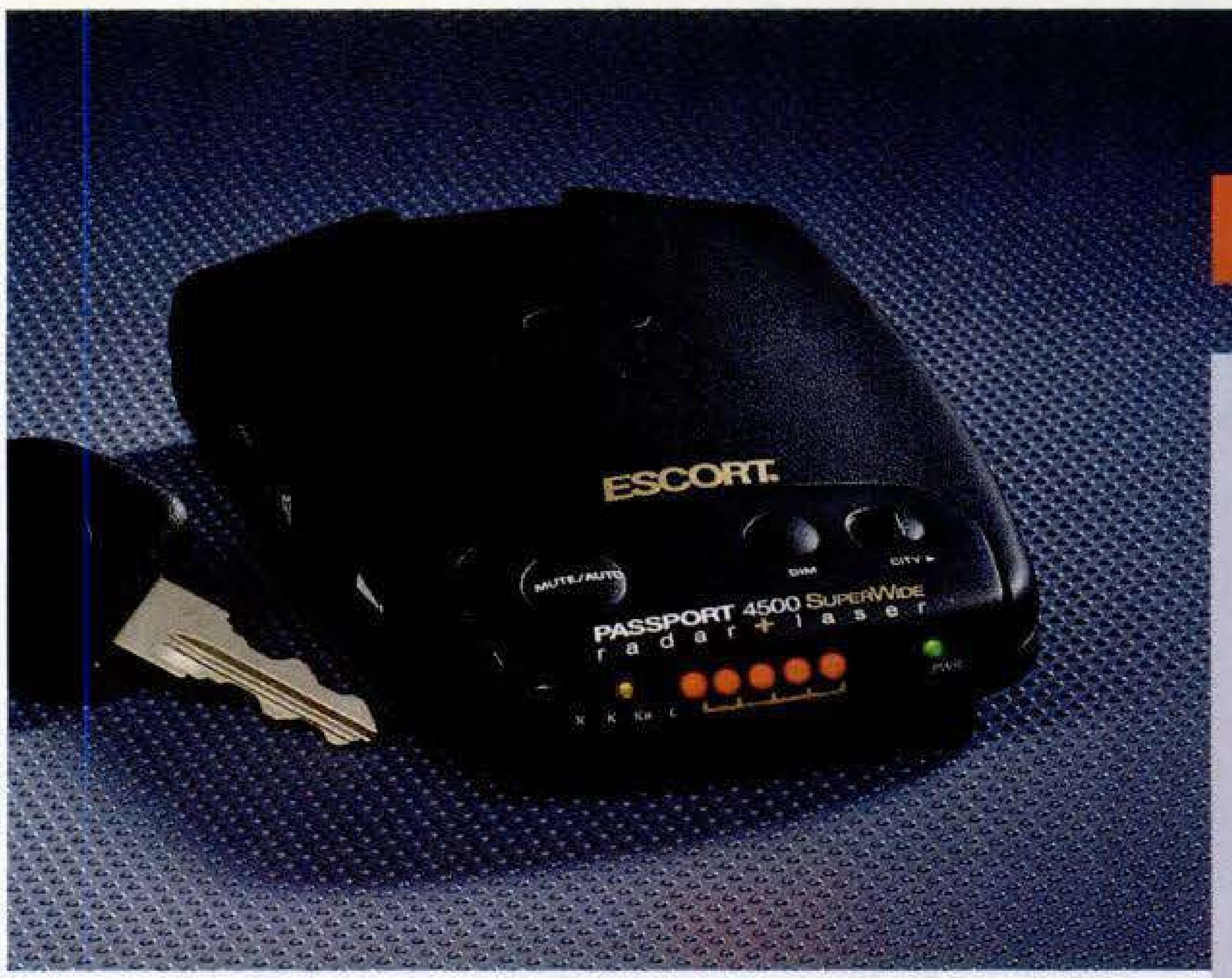

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Passport 4500 SuperWide continues the tradition of excellence carved out by our original Escort and Passport detectors. A perfect synthesis of performance, style and features, Passport 4500 SuperWide is the ultimate in combined radar and laser detection.

Passport 4500 SuperWide not only detects every type of radar and laser used today, it also detects new radar frequencies recently approved but not yet in operation. You're guaranteed complete protection today – and tomorrow.

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Popular Science

THE WHAT'S NEW MAGAZINE

JULY 1993

A TIMES MIRROR MAGAZINE

FOUNDED IN 1872

VOLUME 243

NUMBER 1

COVER BY JOHN B. CARNETT AND TOM WHITE

DEPARTMENTS

EDITOR'S NOTE 6

READERS TALK BACK 8

WHAT'S NEW 10

NEWSFRONTS
Science & Technology **27**
Automotive **36**
Home Technology **42**
Computers & Software **44**
Electronics **52**

PRODUCT INFORMATION 95

LOOKING BACK 104

FEATURES

NEW MICROPROCESSORS

58

They're coming to a PC near you. Their performance claims are seductive, but system prices are steep. Should you bite? Intel's recently released Pentium chip is leading the parade.

DECAVITATOR VS. FLYING FISH

66

How fast can a watercraft sprint for 100 meters with one person as its power source? We now know the answer, and the race for the fastest human-powered watercraft has a winner.

CLEANING UP DEADLY CHEMICAL WEAPONS

70

The United States and Russia built huge stockpiles of chemical weapons. Now both countries must dismantle these obsolete, deteriorating munitions—some so deadly that mere drops of their toxic nerve agents can cause death within minutes.

RESCUING AN AMERICAN ICON

72

Starting in the 1930s, the towering elm trees that once lined the streets of America's towns and cities have been decimated by the Dutch elm fungus. Now, with the development of fungicides and the discovery of new elms that are resistant to the disease, this country's stateliest tree is on the verge of a comeback.

THE EXTRASENSORY CAR

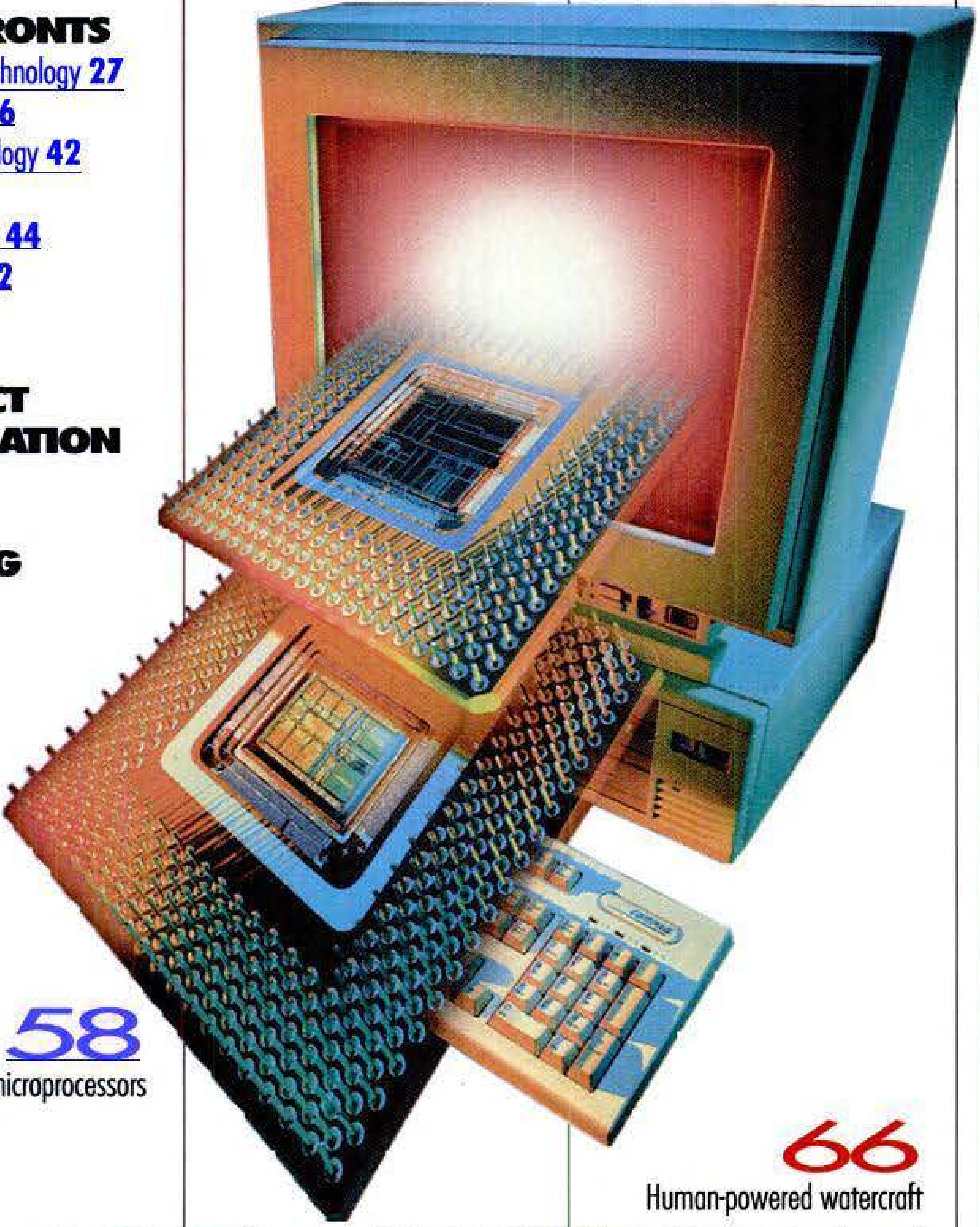
76

Pilots fly safely in pea-soup conditions using sensory-enhancing systems. Someday, drivers will navigate the roads using similar devices. Night-vision, radar braking, laser ranging, and blind-spot detection systems are now under development for cars.

WINDOW TECHNOLOGY PART 2: THROUGH THE GLASS, DARKLY

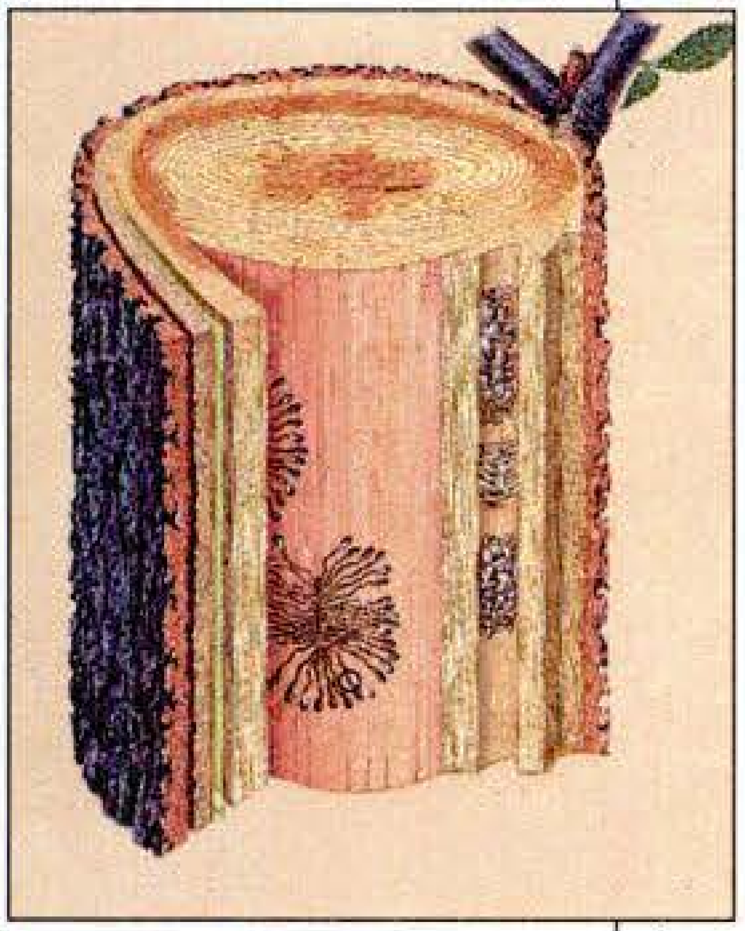
80

Smart glazings that automatically switch from clear to opaque and back again, capturing as much light as possible while rejecting unneeded heat, are nearing the marketplace.



58
The new microprocessors

66
Human-powered watercraft



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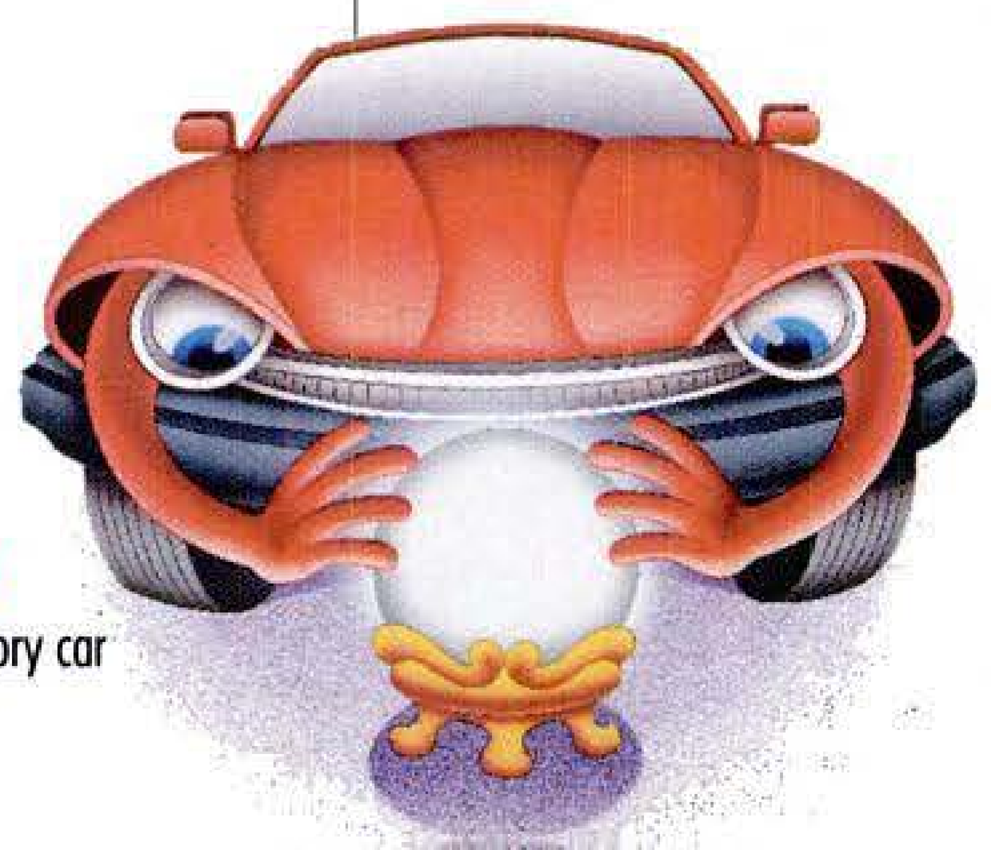
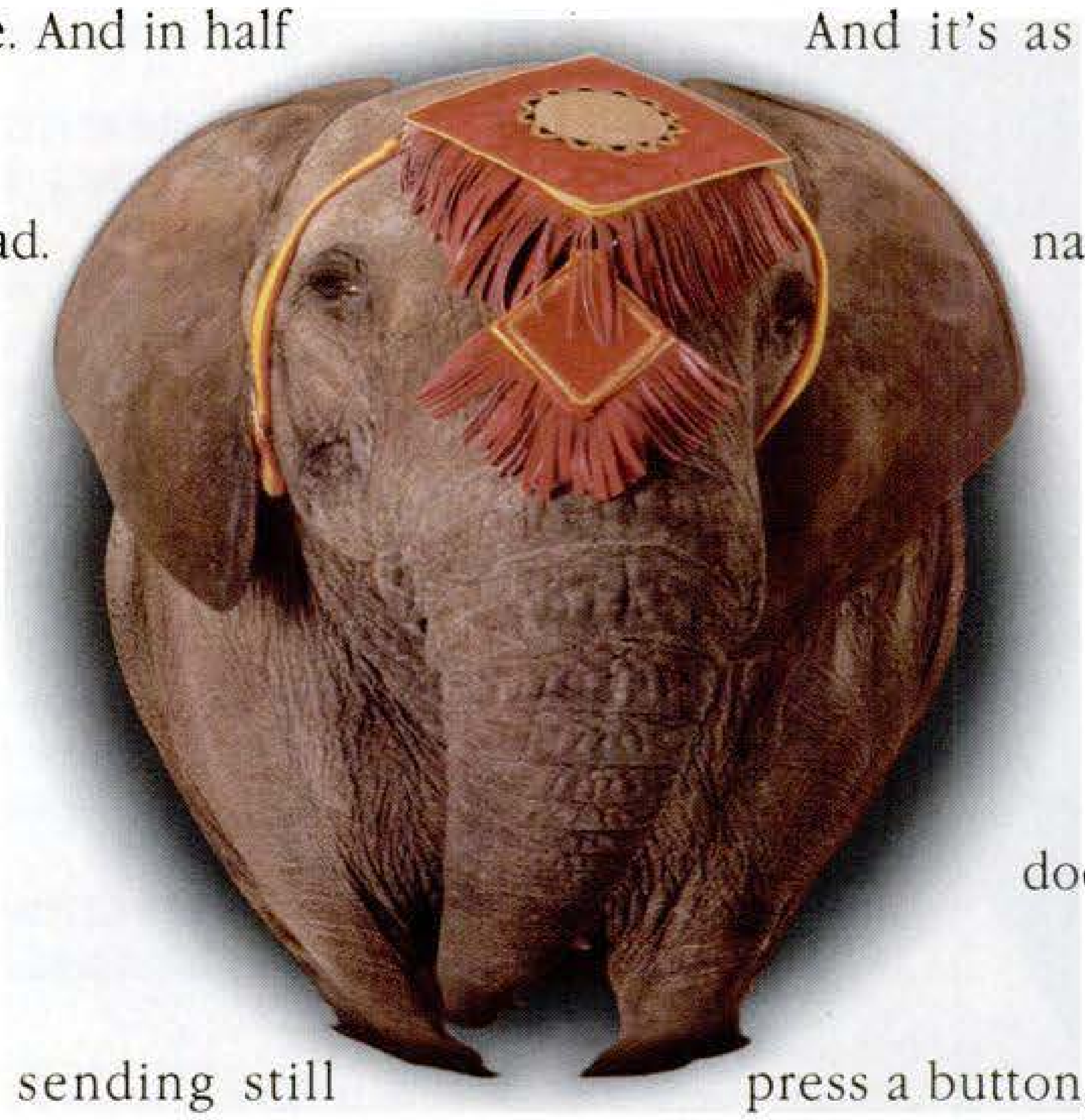
Saving the elm tree



76
The extrasensory car

Imagine being able to instantly move a four-ton elephant thousands of miles through a copper wire.



It would be a fairly amazing feat. A huge pachyderm sent thousands of miles over an ordinary phone line. And in half the time it takes to read this ad.

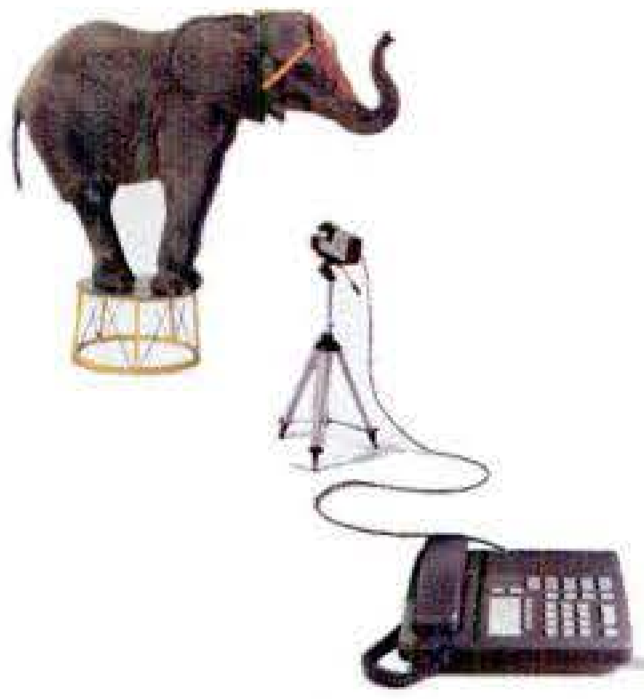
It's possible. With the new *Picasso*™ Still-Image Phone from AT&T.

By capturing and sending still images, the *Picasso* Still-Image Phone allows you to transmit broadcast-quality pictures over ordinary analog phone lines.

From advertising layouts to educational materials, and from blueprints to buildings, if you can see it, you can send it.

And it's as easy to use as any ordinary phone. Once your image is captured from a camcorder, electronic camera or document camera, you simply press a button, and in seconds the image appears in full color on the phone at the other end. Suddenly your teleconference is upgraded to an image conference.

Furthermore, unlike some other still-

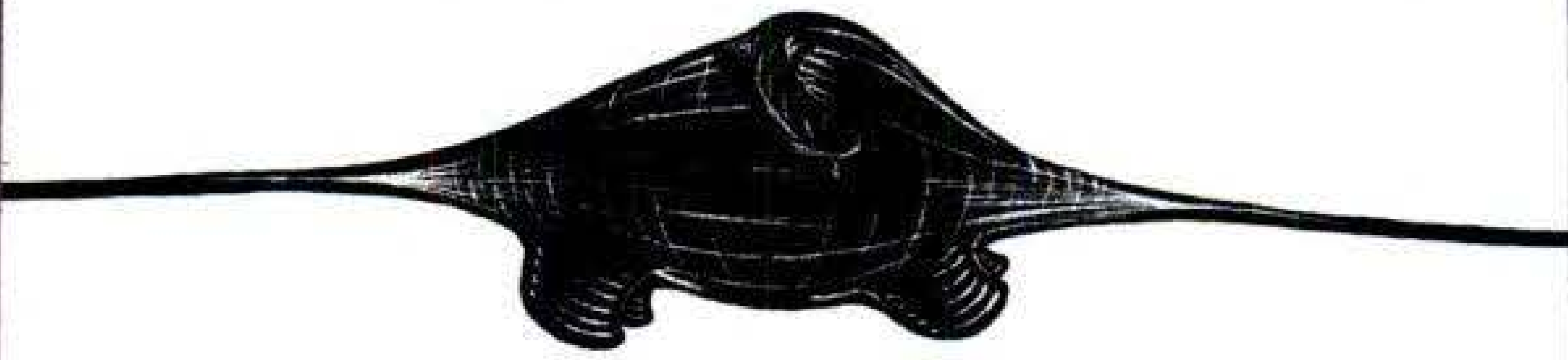


The first step is to capture an image of your subject.

image communication equipment, the *Picasso* Phone has simultaneous voice and image capability. So you can present visuals without interruptions. And since it uses conventional phone lines, you pay only for a normal phone call and send the pictures for free.

(actual picture)

Once the image is inside the phone you can send it to another.



With a *Picasso* Still-Image Phone, you get the immediacy of a phone call with the color and clarity of a television picture.

Which means no more vague conversations full of words like "imagine." No more guessing what something looks like from a rough black-and-white fax. And no more wasting time and money sending unnecessary overnight packages.

(actual picture)

In seconds, the image is received on the monitor of whomever you call. Whether they're across town or thousands of miles away.

If the *Picasso* Still-Image Phone sounds good to you, call **1 800 225-3000** and we'll arrange a demonstration. After all, seeing is believing.

picasso™
STILL-IMAGE PHONE

AT&T

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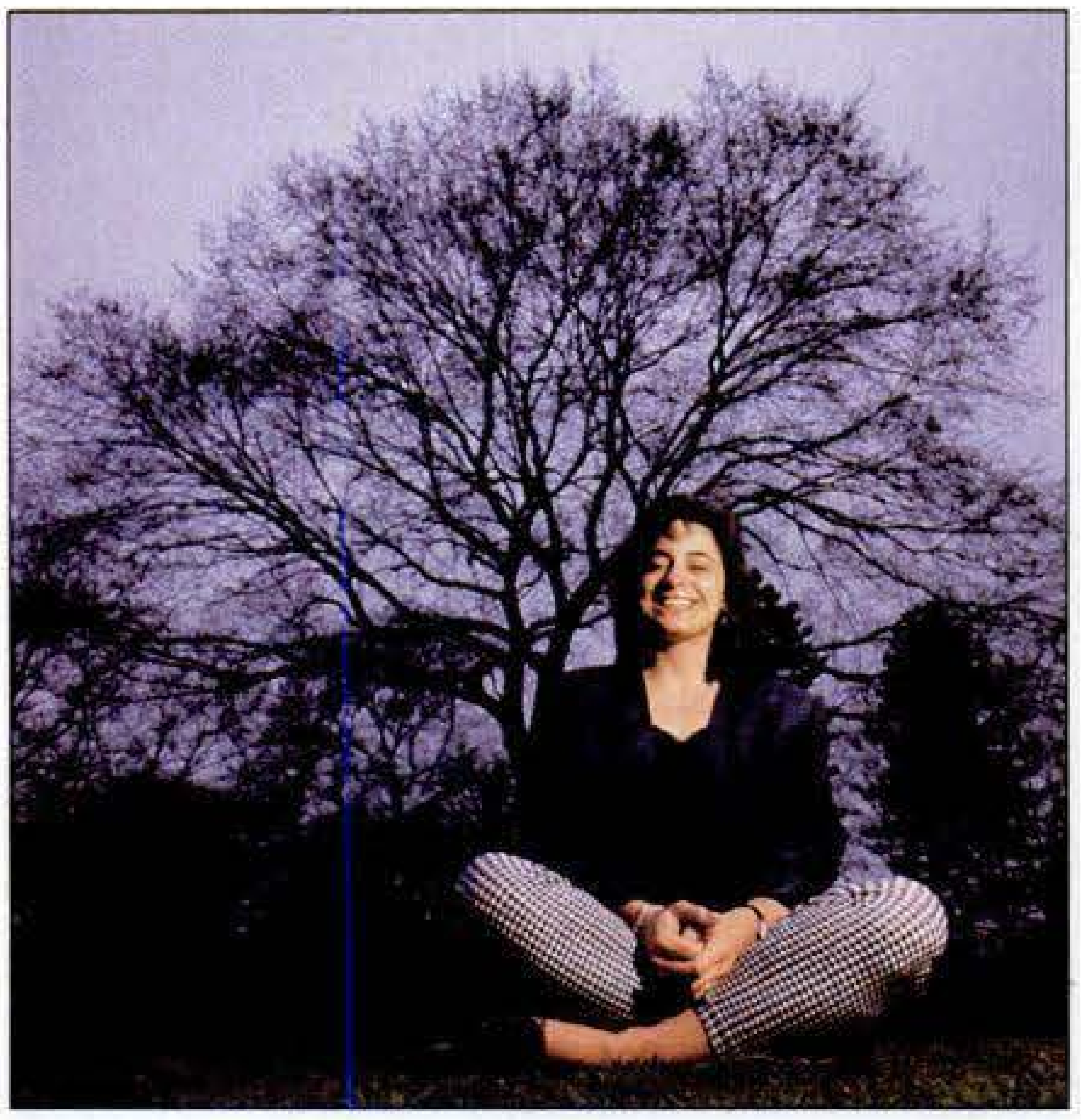
EDITOR'S NOTE

REVERSAL OF MISFORTUNE

When 19th-century landscape architect Frederick Law Olmsted designed a broad Brooklyn thoroughfare called Ocean Parkway, stretching from his Prospect Park masterpiece to the Atlantic Ocean, the columnar elm was his tree of choice. In its halcyon days, millions of elm trees throughout the United States provided leafy archways for carriages, pedestrians, and, later, Sunday drivers. Yet by the mid-20th century, most of the country's elm trees were dead or dying, victims of a lethal fungus known as Dutch elm disease.


JOHN B. CARNETT

In New York's Central Park, Mariette DiChristina's smile reflects the reversal of misfortune for America's elm trees.

Associate Editor Mariette DiChristina reports that there has been a turnaround in the elm's misfortunes in recent years. In fact, the stately tree appears to be on the verge of a comeback. Researchers have found new ways to block the disease, breed new hybrids with greater resistance, and capitalize on the mighty elm's already formidable character. Here's a success story of technology coming to the rescue of an American icon.

If you're one of the approximately 50 million desktop computer users in the United States, you're most likely aware of a new generation of microprocessors, including Intel's Pentium chip, that is about to take center stage. Squeezing millions of transistor circuits into a sliver of silicon little more than a half-inch square, these new brains for PCs are up to three times more powerful than the current state of the art, for faster, more advanced capabilities. Perhaps more significantly, these chips promise computers that are easier to use and more functional.

It's a classic good-news, bad-news story that contributing editor Christopher O'Malley sorts out in Power Chips, the first of a two-part series on personal computer technology. On the bright side, the new processors usher in unprecedented capabilities for user friendliness—handwriting and speech recognition, for example—and greater horsepower for the demanding tasks of digital video and audio.

The bad news is that deciding which processor—that is, which computer—is the right one for you just got a lot more complicated. In this issue, O'Malley helps you sort through today's multitude of hardware choices. Next month, he scrutinizes the software side of the equation, where new-and-improved operating systems are also breaking through technological barriers.

Night-vision systems, laser-reflecting range finders, infrared imaging, head-up displays: Sounds like the stuff of the latest combat aircraft, right? Automotive Editor Dan McCosh reports that they also represent the latest crop of technology being developed for collision-avoidance and navigation systems in the family car of the not-too-distant future.

Much of this sophisticated gear is designed to extend the senses and reflexes of the driver. The tricky part of adapting such devices for automobiles is designing the communications link with the driver. Should the interface consist of audible or visual warnings—or both? Should the driver maintain control or should automatic overrides take command of the vehicle? Much research is still needed to answer these questions, but already some experimental systems have been credited with saving lives. McCosh predicts that sometime in the next decade we're likely to be driving cars in which extrasensory gear is as commonplace as the rearview mirror.

Fred

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The 1957 Ford Fairlane 500

SKYLINER

With retractable hardtop that folds down into the trunk...just like the original!

For the first time ever, this revolutionary convertible hardtop captured in an astonishing die-cast replica precision-engineered in 1:24 scale from more than 140 separate parts. Fully authorized by Ford Motor Company.

Shown approximately actual size of 8¾" (22.22 cm) L. Scale 1:24.

In the decade when man first reached for the stars, it was a natural. A quantum leap in automotive technology, it helped make the '50s fabulous. The 1957 Skyliner. The first practical, automatic retractable hardtop. Now, the ultimate *gizmo* car of the Fifties becomes a sizzling die-cast re-creation from Franklin Mint Precision Models.

From those snazzy tail fins to the "picnic basket" storage bin in the trunk, it's all here!

Swing open the door for a trip through time. The fully instrumented dash, soft seats and the steering wheel that actually turns. The hood opens to reveal the highly detailed re-creation of the 312 cid Thunderbird "Special V-8." And, of course, the trademark hardtop folds down into the trunk to capture that wind-through-your-hair feeling of the real Skyliner.

The price for this specially imported classic, $120, payable in monthly installments.

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Please mail by July 31, 1993.

YES! Please enter my order for the precision-engineered replica of the 1957 Ford Fairlane 500 Skyliner, to be sent to me fully assembled and ready for immediate display.

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READERS TALK BACK

Math: A Logical Science?

In "Why Scientists are Thinking Small" [April], you state that while researchers can make a single atom or molecule perform basic logical functions important for computing, their devices can't do simple arithmetic. Wait a nanosecond. Isn't all computing —word processing, number crunching, graphics—based on logic functions?

Doron Hutton
La Mesa, Calif.

Loosely speaking, you're correct. But mathematicians and scientists usually distinguish between formal logic used in reasoning (such as, if X and Y are true, then Z is true) and arithmetic (X+Y=Z). Arithmetic requires electric signals to be amplified, whereas logic requires switching signals around—a simpler task.—Robert Langreth

An Interesting Retrospective

Mr. Babbage's Wonderful Calculating Machine" [March] is now enshrined in my collection of "old" computer books and "antique" computers. I enjoyed your modern insights into why Babbage didn't get his machines built—personal problems and lack of cash. Most of my tomes blame the engineering skills of the day for preventing Babbage's dreams from becoming reality. While I'm sure that was a problem, your explanation is more human—and much more likely.

James F. Barrett
Kimberling City, Mo.

No Mention Of Dat?

The title "Digital Recording Arrives" [April] is misleading. Digital audio tape (DAT) has been available for awhile. Also, it is superior to the digital compact cassette (DCC). DAT copies a CD exactly, instead of using the DCC's 25 percent compression method. But you didn't even mention DAT.

Jim Wallace
Canton, Ga.

Will Hot Rocks Lose Their Heat?

Has anyone studied the effects of extracting geothermal energy from the hot rocks in Earth's sublayers ["Science Newsfront," April]? Will this cooling eventually cause these layers to contract and have an adverse effect?

Raef Meves
Palos Hill, Ill.

Enough heat rises from Earth's core so that the small amount extracted from the sublayers makes no noticeable difference.—Dawn Stover

The Pattern's The Same

From General Motors, the company that bought out all the clean electric trolleys and replaced them with smelly diesel buses, comes the 257-mph Oldsmobile. Meanwhile, back at the factory, General Motors has pulled the plug on making electric cars ["Automotive Newsfront," April]. The more things change, the more they stay the same.

Wilbur Rhodes
Kittery, Maine

Sun Space

Your illustration showed that solar collectors take up a lot of space ["Buried Sunshine Heats Sports Centers," March]. But the text said that the collectors occupy about one-quarter acre.

George Helmholz
Covelo, Calif.

The entire project will take up six to seven acres, and most of that space will be for the collectors. Heating a large stadium and gym requires a lot more energy than, for example, heating a single house.—Dawn Stover

Corrections: The Architectural Energy Corp. mentioned in "The Science of Energy Efficient Homes" [April] is in Boulder, Colo.

The 2.4-liter engines in the 1994 Mitsubishi Galant ["Automotive Newsfront," June] feature four valves per cylinder.

AT&T Image Solutions has raised the price of its Picasso Still-Image Phone ["Electronics Newsfront," June] to $3,295. A mouse is included.

Address letters to Readers Talk Back, POPULAR SCIENCE, 2 Park Ave., New York, N.Y. 10016. Or fax your letter to us at 212-481-8062. Letters may be edited for space and clarity. We regret that we cannot answer unpublished letters.

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The 1993 Buick Century. Safety first.

Buick Century, a car that's known for comfort, quality and value, is now available with a feature that will make you feel better than ever: a driver air bag, standard equipment.*

Century receives top ranking.

Buick's dedication to your safety is nothing new. In fact, in a recent study by the Highway Loss Data Institute, Century was the only mid-size car to receive top rankings for both injury and collision claims experience.**

Century new-vehicle quality.

Add this to the fact that Century ranked among the top ten models in J.D. Power and Associates' Initial Quality Study† and you'll know it's a car you can feel very good about driving.

Call 1-800-4A-BUICK to find out more. Or see your Buick dealer for a test drive today.

BUICK®
The New Symbol For Quality
In America.

Buckle up, America!

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*Available on all Century models, optional on Special Sedan and Wagon.

**Based upon both injury and collision claims experience (for 1989-91 car models).

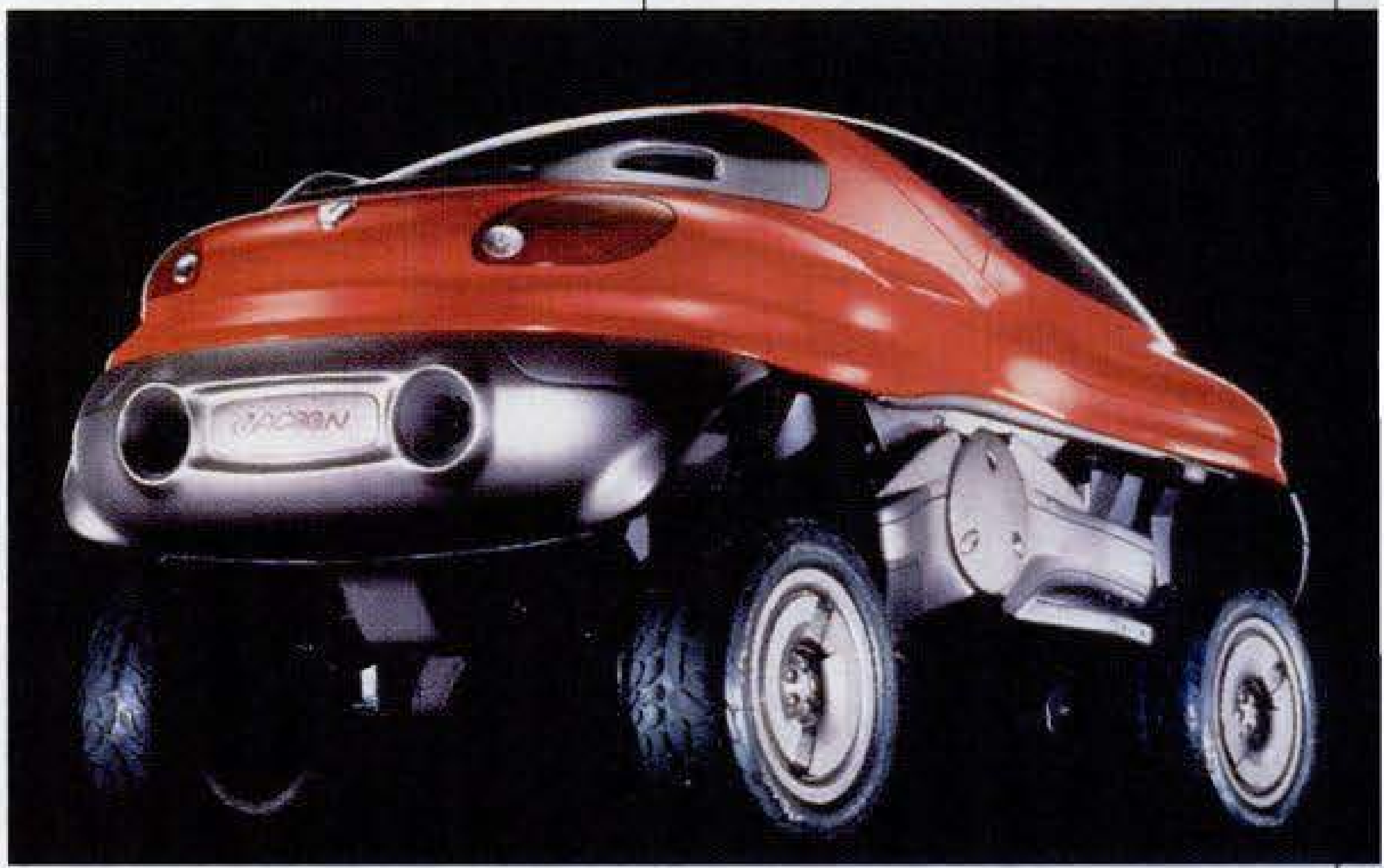
†J.D. Power and Associates 1992 Initial Quality Study℠ based on 33,573 consumer responses indicating owner-reported problems during the first 90 days of ownership.

WHAT'S NEW

EDITED BY MARCELLE M. SOVIERO AND SUZANNE KANTRA

WORKOUT VEST

The Ripp RTV athletic training vest is designed to vary the intensity of a workout. Weight is added incrementally by plugging up to 20 one-pound weights into its hollows. The $90 soft-foam vest comes with four one-pound weights. Ripp Fitness,
920 S.W. 3rd Ave., Suite 200,
Portland OR 97204.



GO-ANYWHERE CAR

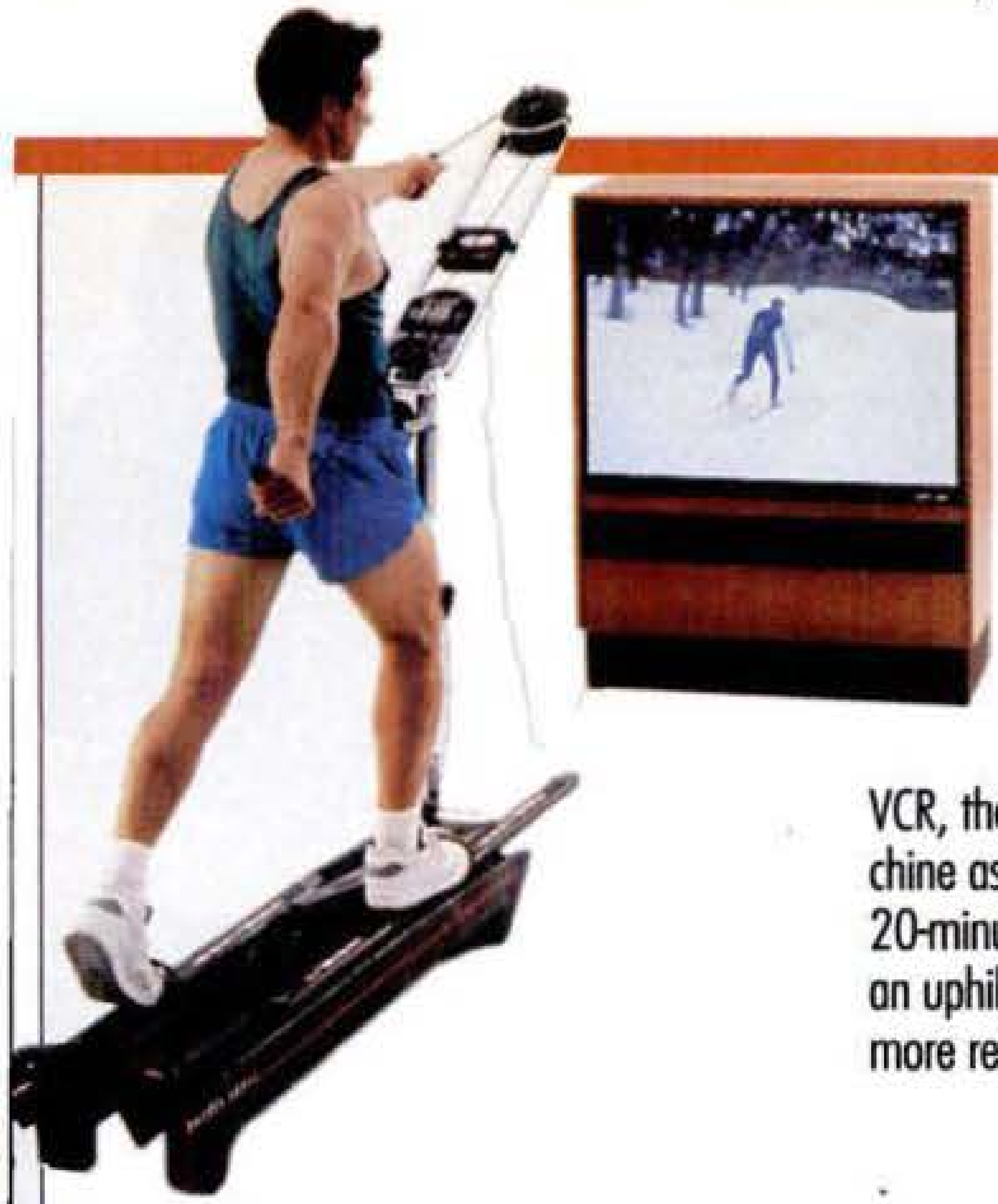
When on land, Renault's amphibious Racoon concept vehicle can increase its ground clearance to nearly 20 inches, thanks to wheel "legs" that can be hydraulically lengthened. The four-wheel-drive machine has a three-liter V6 engine that delivers 262 hp through a six-speed gearbox. When on water, the vehicle's twin hydrojets produce a cruise speed of five knots.

SMOOTH GRIPPERS

Robo-Grip pliers differ from conventional adjustable pliers because the tool's jaws adjust freely and lock easily. How? A spring-loaded cam at the joint has teeth that engage once the jaws contact the workpiece. Squeeze the handles, and the teeth disengage, releasing the jaws. Available in six- and nine-inch versions, the pliers cost less than $30. Applied Concepts,400
Commerce Blvd., Lawrence PA 15055.

NEW NOTAR CRAFT

The McDonnell Douglas MD Explorer is the latest helicopter to employ the Notar anti-torque system, which replaces the standard tail rotor. This technology uses the engine exhaust to cancel anti-rotation, the craft's inclination to move in the direction opposite that of the rotor. In addition, the Explorer's flexible rotor blades require fewer parts, so there's less maintenance and weight.



HOME SKIING

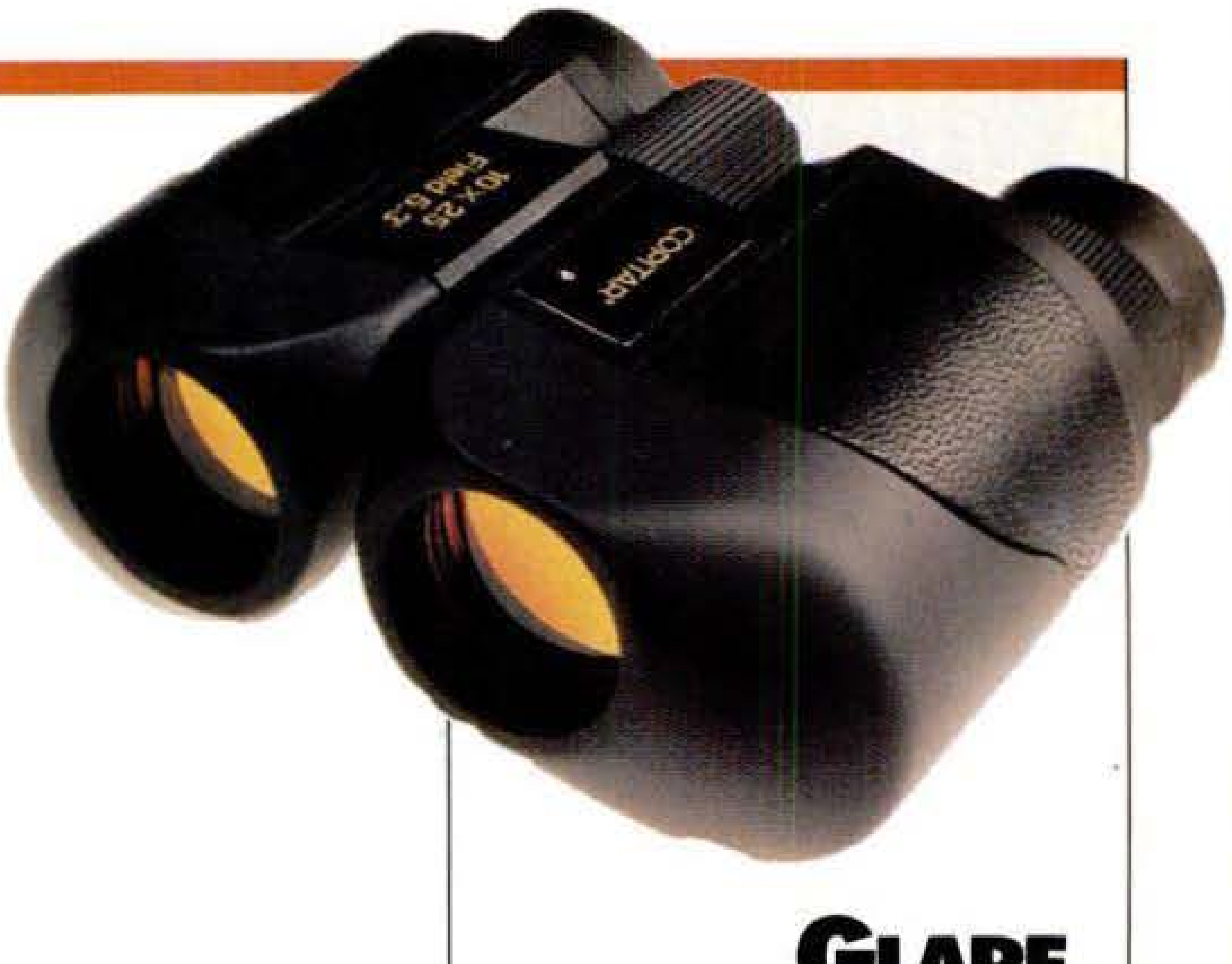
SportVision, an interactive cross-country skiing system, adds a visual dimension to NordicSport Ski exercise machines. Used with your TV and VCR, the system varies the resistance of the machine as a videocassette displays one of three 20-minute-long "trails." When the video shows an uphill climb, for example, you experience more resistance. Price: $200.

MIRROR MAC

Nutek One is the first independently developed hardware/software computer package with an operating system that runs Macintosh software. Available with different configurations, Nutek One includes a Motorola 33-megahertz 68030 processor, a Mac-compatible SCSI connector for external devices, and audio-in and -out jacks. Price: $899. NuTek U.S.A. Corp., Box 160505, Cupertino CA 95016-0505.

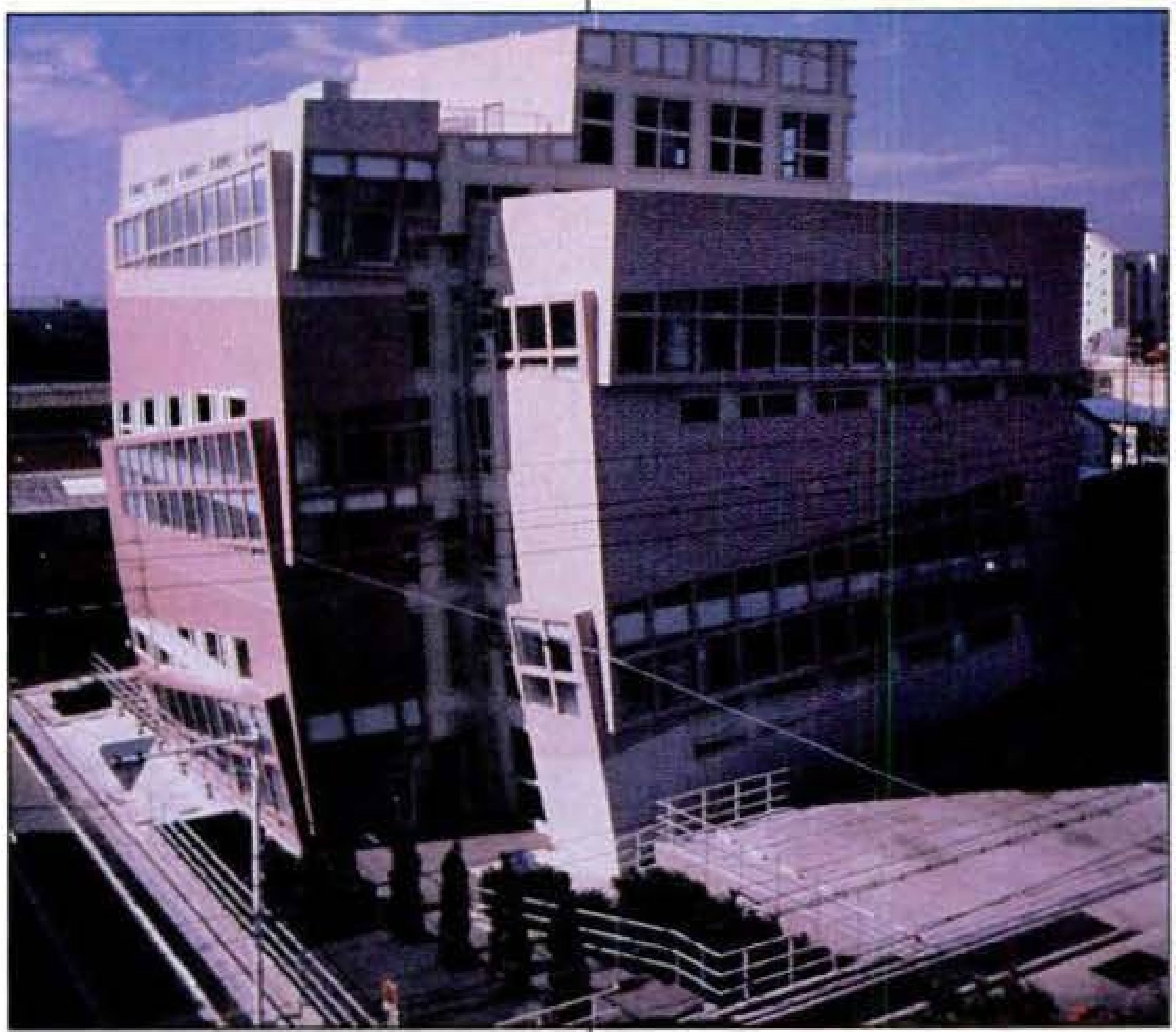
LONG-RANGING ZOOM

The IS-3 DLX is the first in the Olympus IS Series of autofocus zoom-lens-reflex cameras to offer a 35-to-180mm built-in zoom lens. The optional $225 telephoto lens (shown) increases the zoom range to 300mm. Price: $900.



GLARE STOPPERS

The lenses on the M-125 SkyView binoculars are coated with a combination of materials that blocks most of the sun's infrared and ultraviolet rays. The $140 pocket-size binoculars have 10X magnification and weigh just 8.9 ounces. Copitar USA, 17 Renwick Ave., Huntington NY 11743.



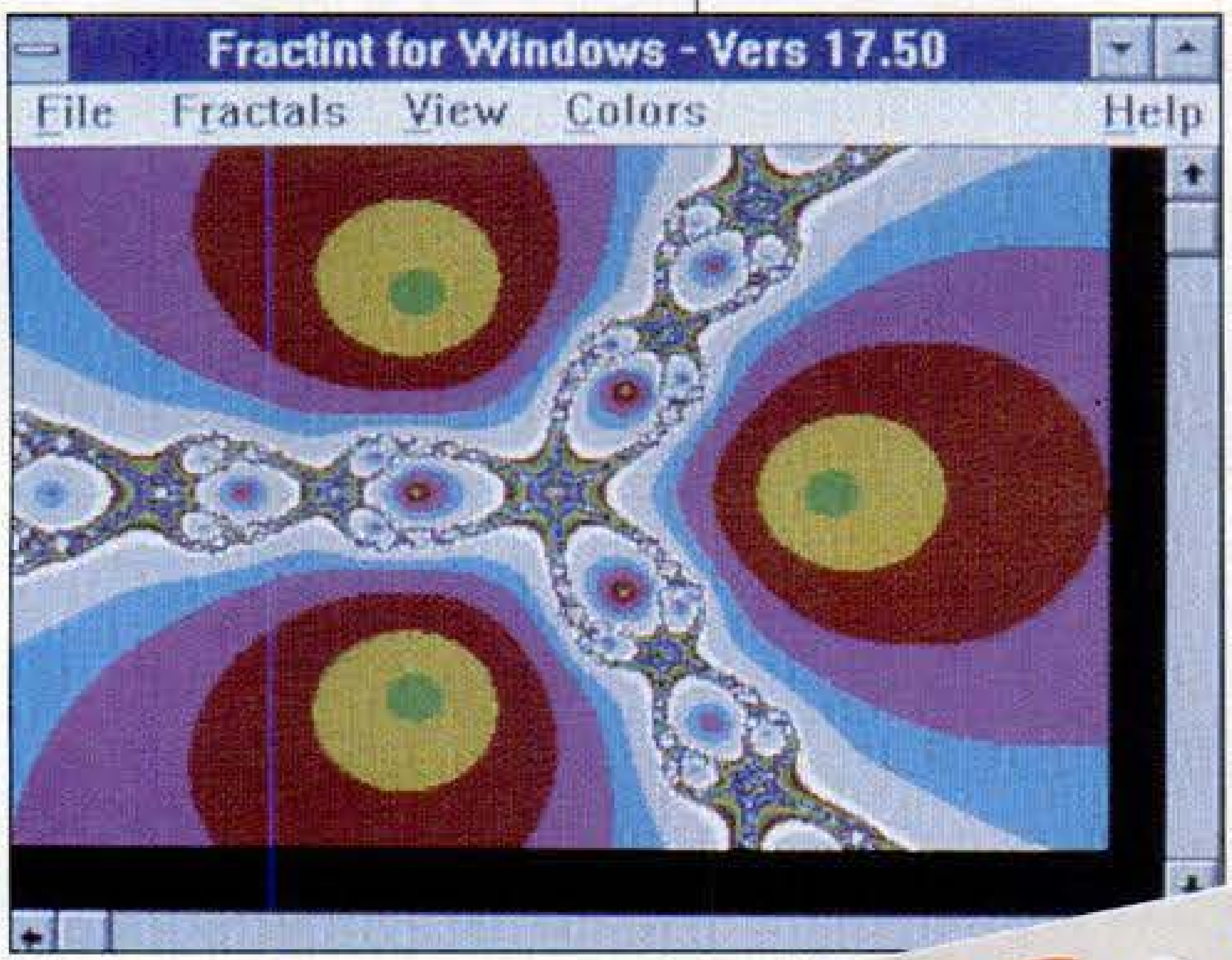
NEWSPEED

WOBBLY STYLE, NOT STRUCTURE

Although this Tokyo office building appears off-balance, it is actually equipped with advanced earthquake-damping mechanisms. Designed by American architect Peter Eisenman, the $20 million building is disorienting on the inside too: The ceilings, walls, and even some floors play with a viewer's perspective.

See POPULAR SCIENCE's What's New products June 19 and 20 on CNN'S *Science & Technology Week,* which airs every Saturday at 11 a.m. and Sunday at 12:30 p.m. Eastern Time

WHAT'S NEW



FUN WITH FRACTALS

Explore fractals—complex mathematical objects, including natural growth patterns like ferns or snail shells—with "Fractals for Windows," a book packaged with a software program called Winfract and 3-D glasses. The book guides you through the steps necessary to create your own fractals, provides "recipes" by artists, and has a library of 80 fractals. Price: $35. Wait Group Press, 200 Tamal Plaza, Corte Madera CA 94925.

IF THE SHOE FITS . . .

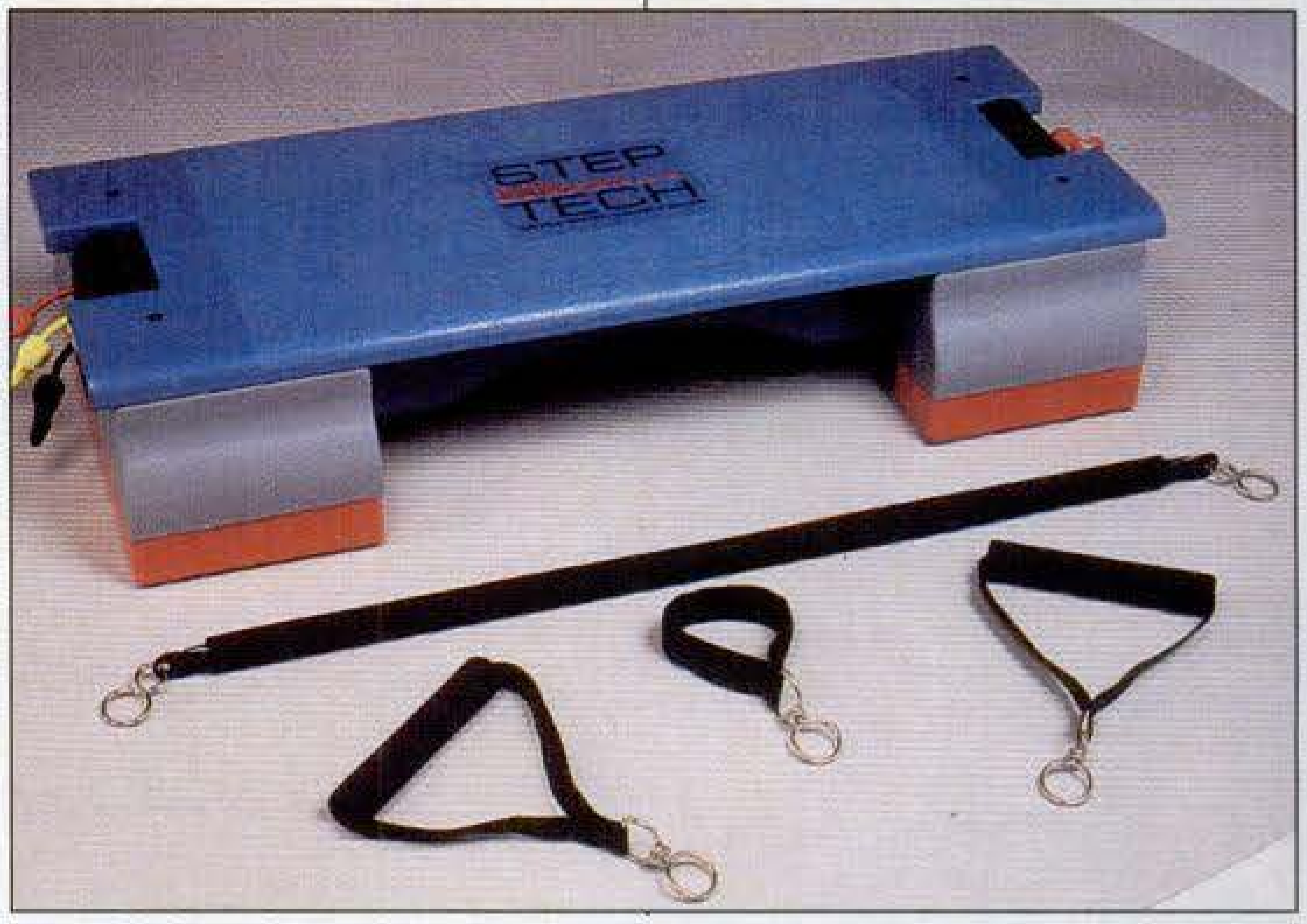
The FootMark 2100 helps consumers choose properly fitting shoes. When you step on the machine's measuring pad, infrared and pressure sensors calculate your foot's every dimension. It then creates an on-screen computerized image and recommends a shoe size. FootMark 2100, Suite A1120, 1150 Hammond Dr., Atlanta GA 30328.

RETRO HOT ROD

The Plymouth Prowler concept car is a hot rod that is designed to meet production car safety standards, including dual air bags, front and rear bumpers, and required lighting. Its 3.5-liter, 24-valve OHC V6 engine, rated at approximately 240 hp, drives the rear wheels via a high-speed drive shaft mated to a rear-mounted four-speed transaxle—components borrowed from Chrysler's LH sedan.

STRAP ATTACK

Secure your camera, camcorder, or binoculars with the Gotcha Wrist Strap. Fasten one end of the strap to the equipment; the other end is tethered to a band that wraps around your wrist with a hook-and-loop closure. Op/Tech U.S.A., 290 Arden Dr., Belgrade MT 59714.



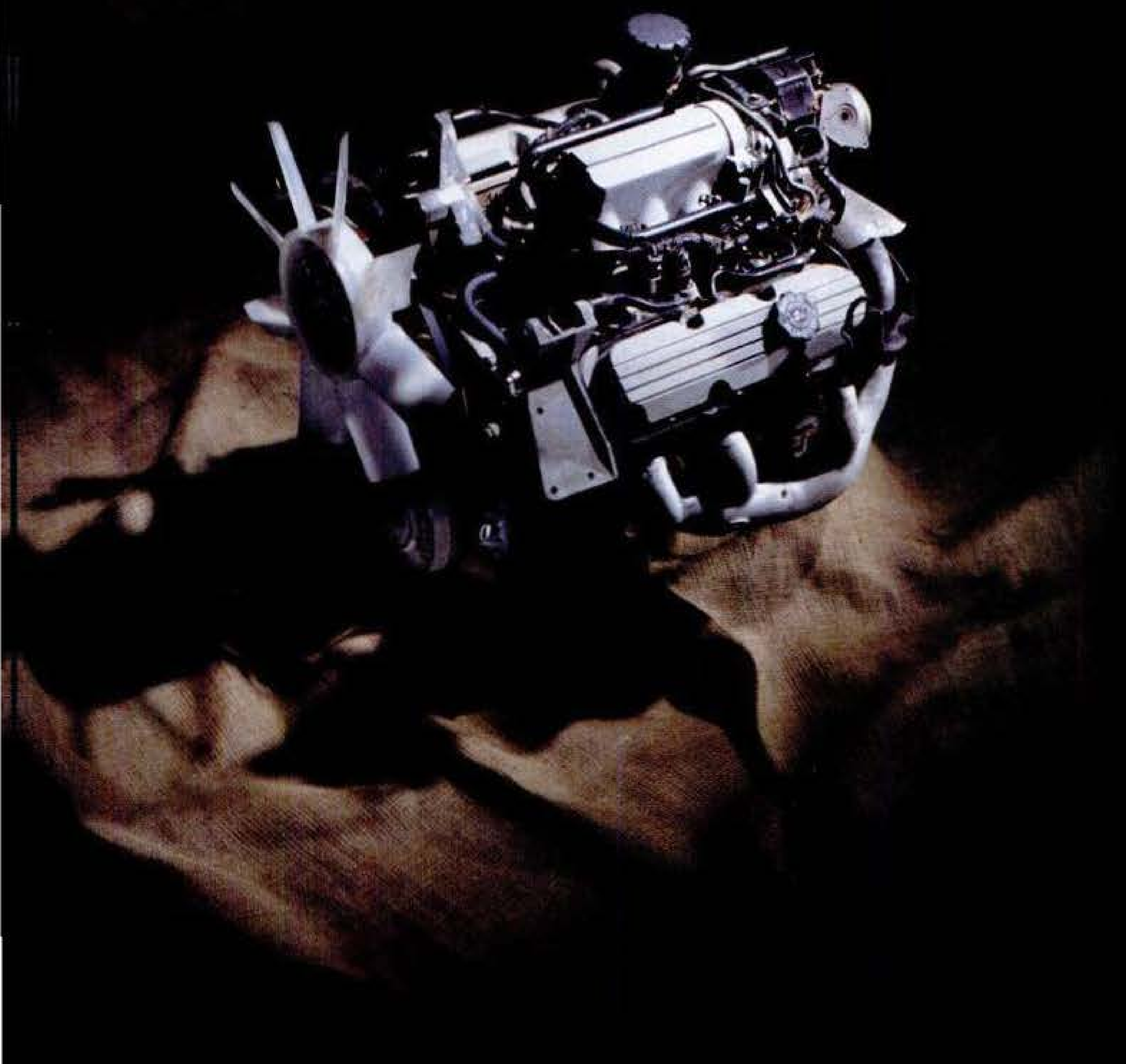
A STEP UP

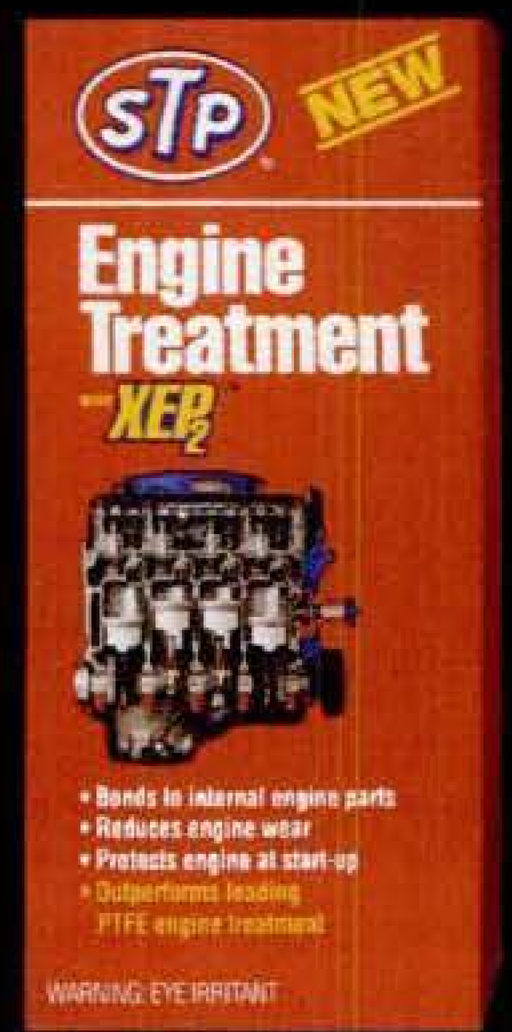
The Step Tech Total Body Conditioner beats conventional exercise steps because it features three pulleys on either side of the step. These enable you to perform as many as 60 different exercises for thighs, arms, legs, chest, and back and shoulders, in conjunction with the traditional step workout. Price: $139. Formula Ventures, Box 601695, North Miami Beach FL 33160-1695.

IT STARTS EACH DAY COLD, NAKED AND VIRTUALLY UNPROTECTED.

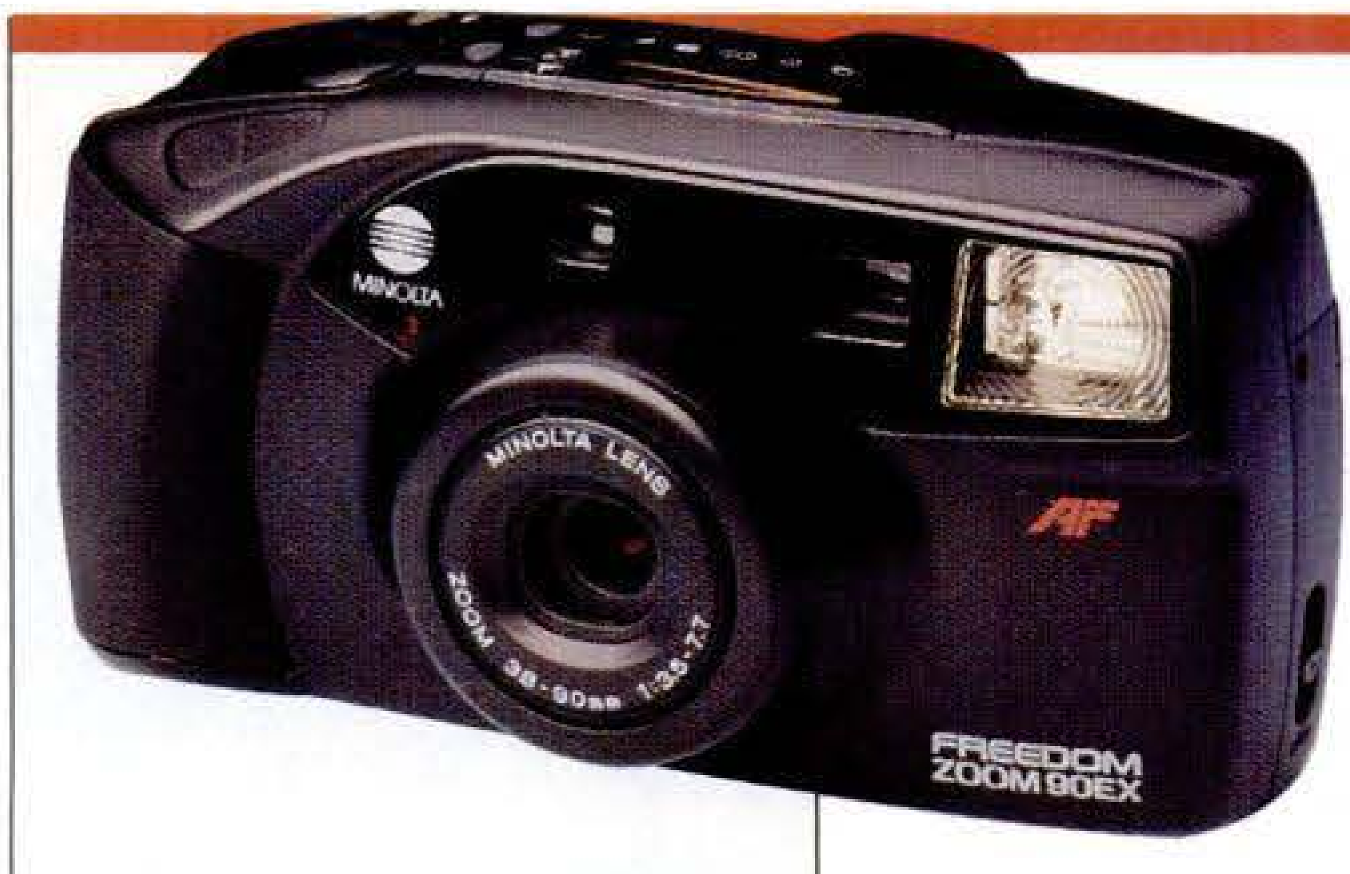
Your poor engine. At start-up, it's only protected by a thin film of oil. It has to wait precious moments for more oil to be pumped up from the pan. The result? Friction and metal-to-metal contact. In fact, most engine wear occurs at start-up. Help stop it by using new STP® Engine Treatment with XEP2.™ This breakthrough formula actually bonds to internal engine parts providing protection from the moment you turn the key. Durable protection proven in independent lab tests to stay put, start after start. Don't send your engine out into the world without new STP Engine Treatment. Help stop engine wear before you start.

FIRST BRANDS




STP
NEW
Engine Treatment
with XEP2
• Bonds to internal engine parts
• Reduces engine wear
• Protects engine at start-up
• Outperforms leading PTFE engine treatment
WARNING: EYE IRRITANT

HELP STOP IT BEFORE YOU START.



FEATURE FRENZY

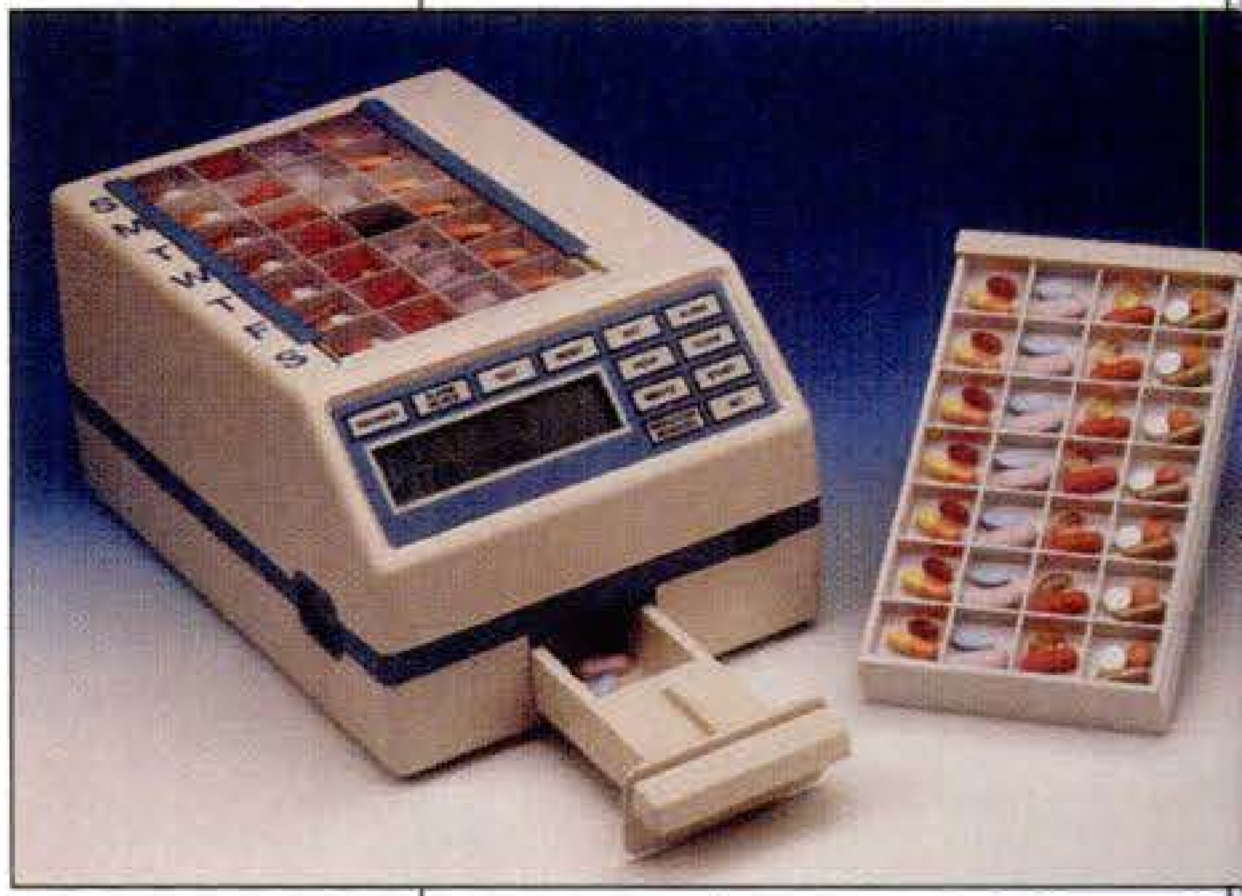
Minolta's Freedom Zoom 90EX 35mm autofocus camera has a 38-to-90mm power zoom lens with a built-in zoom flash. A process called Eye-Start uses an infrared sensor to activate automatically the multi-beam autofocus and autozoom systems whenever the camera is raised to the eye. Special modes enable users to take landscape, night portrait, and double-exposure photographs. Price: $359.

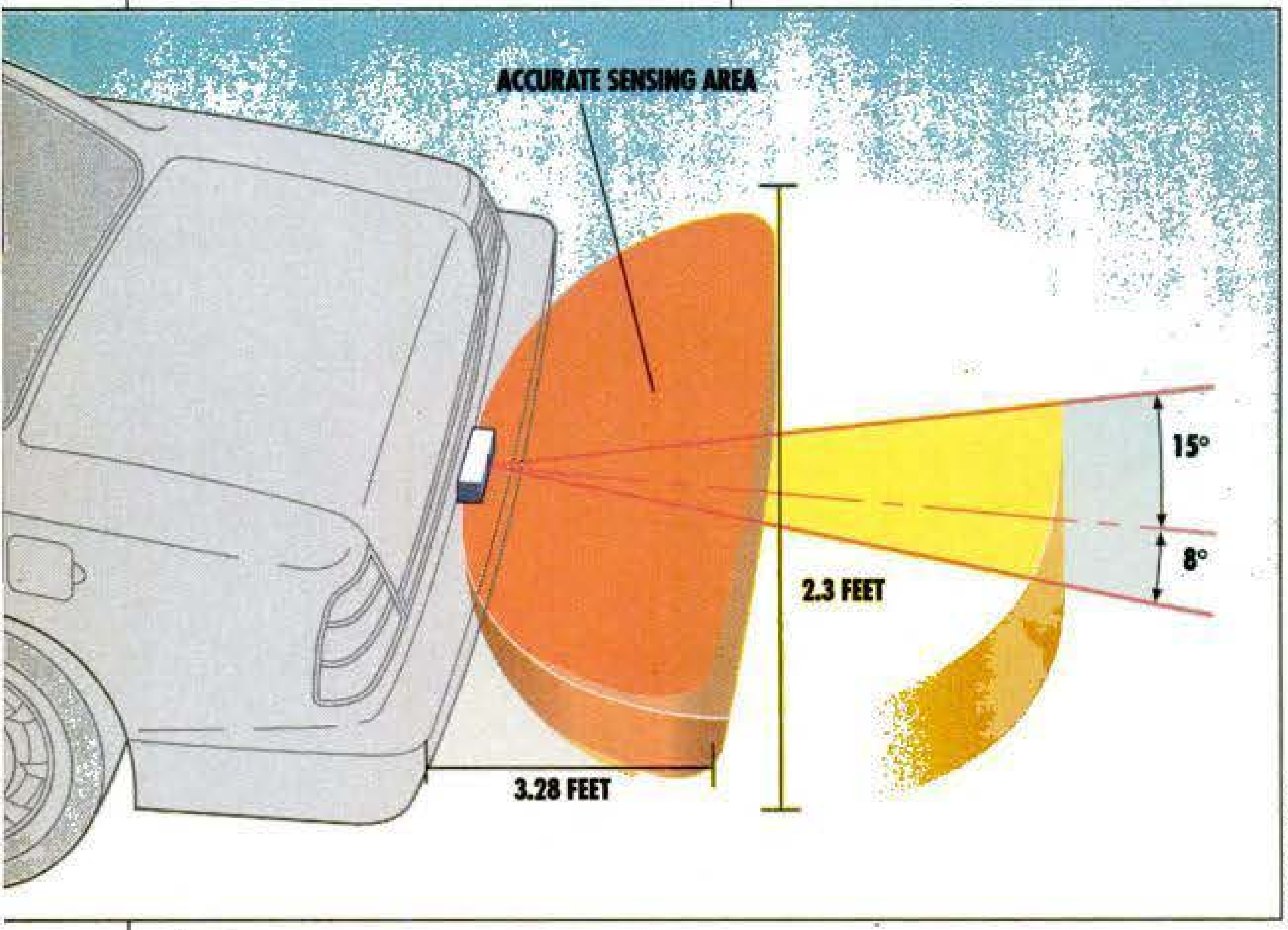
THIS COMPACT THINKS BIG

The letter "C" in Mercedes C-class vehicles stands for "compact," even though the cars are 1.5 inches longer and have more interior space than the 190-class models they replace. There's a choice of four multivalve engines (from 122 to 197 hp), plus two four-valve, ultraclean diesels. Standard equipment includes a driver-side air bag and antilock brakes.

MEDICATION ORGANIZER

CompuMed simplifies your prescription medication schedule: It emits audio and visual alarms and dispenses the necessary pills while displaying instructions. Battery backup ensures continuous operation if power is interrupted. Price: $595. CompuMed Inc., One Pitchfork Rd., Meeteetse WY 82433.





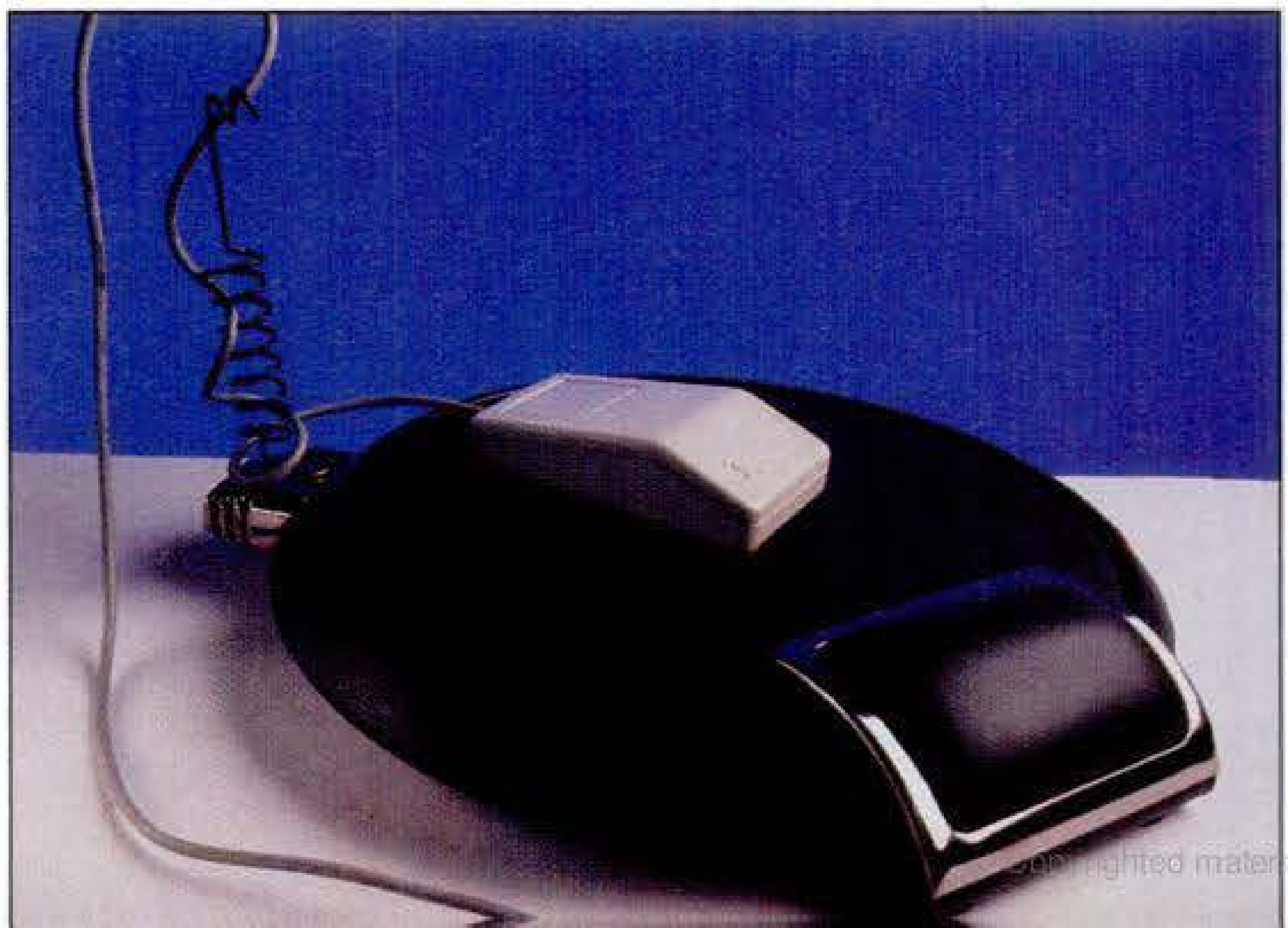
MARIO FERRO

REVERSE ALERT

When you shift your car into reverse gear, Back Radar detects objects behind your vehicle. Mounted on or under the rear bumper, the ultrasonic system sounds an alarm if there's an object within a 3.3-by-2.3-foot area. The retrofit device costs $95. Hako International, 311 Ohua Ave. #505E, Honolulu HI 96815.

EASY DOES IT

The Mouse Arena's padded-leather palm rest supports your hand and wrist in a comfortable position and adjusts for right- or left-handed users. The wire guide prevents the cord from tangling and ensures sufficient cord slack. Price: $25. Forminco, 9610-A Ignace, Brossard, Quebec J4Y 2R4, Canada.

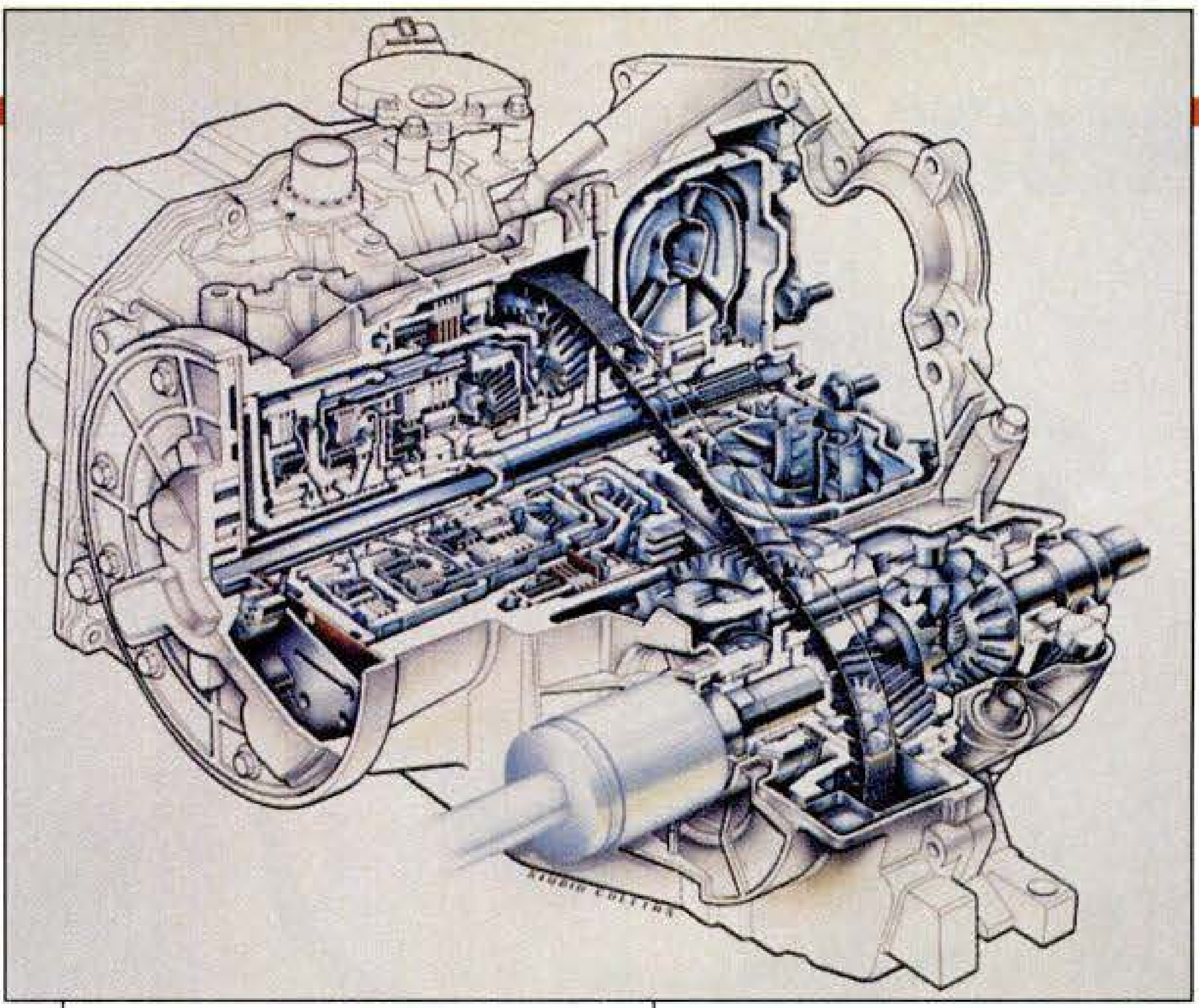


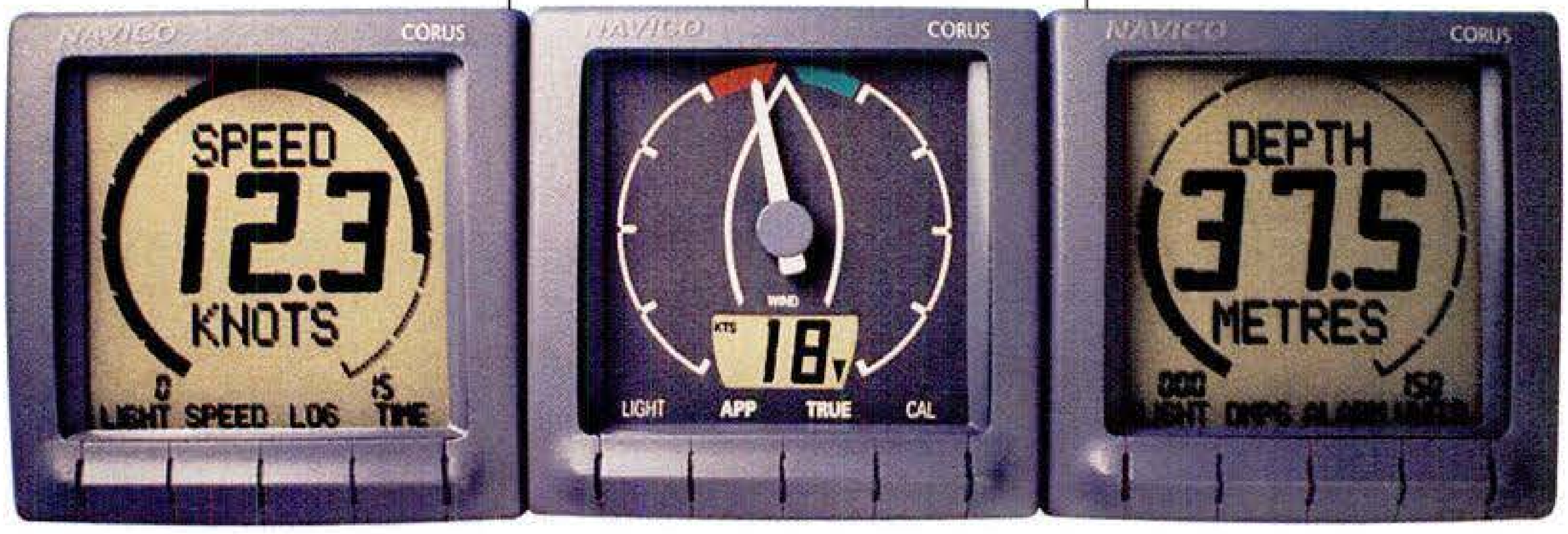
A TOUCH OF LIGHT

This three-foot-long neon light stick stands on a tabletop or floor to accent an office or home with a beam of pink, blue, or lilac light. The Odyssey light stick pivots, enabling it to be placed in five positions. Price: $79. Cicena, Suite 901, 584 Broadway, New York NY 10012.

SMART AUTOMATIC

Ford's CD4E automatic transmission determines the optimum shift strategy for various driving conditions. By processing information from seven transmission functions and 11 engine functions, the system can, for example, compensate for changes in temperature and altitude. In addition, two driver-selected operating modes—sport and economy—alter the shift pattern accordingly.





MODULAR SAILING

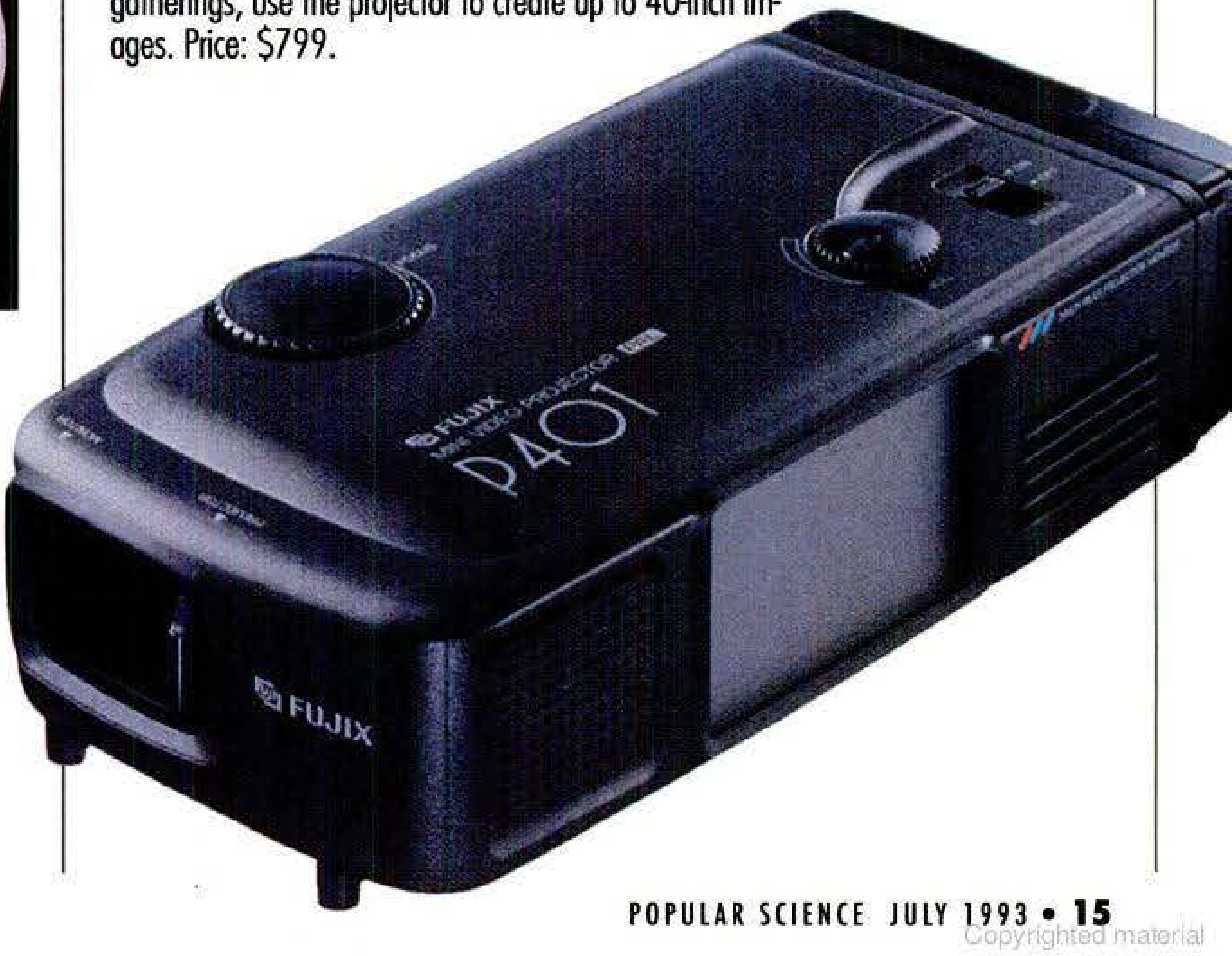
Unlike conventional marine instrumentation, which is arranged in one central control station, Navico's line of Corus Instruments consists of several individual displays and sensors that are placed at different locations on the boat and are linked by a simple wiring system. This enables you to access any aspect of the boat's performance—such as its speed—from any display. Prices start at $600 for one display and one sensor. Additional displays can be added as necessary. Navico Inc., 7411 114th Ave. N., Suite 310, Largo FL 34643.

SHOP TECH

Signing a credit card receipt may one day mean writing on a computer tablet. The NCR 5991 automatically records purchases, reducing retailers' paperwork as well as the chance of errors. The $1,095 device could also handle bank debit cards and electronic checking services as well as verify customer signatures. A magnetic-stripe reader is optional.

PROJECTOR OF PROPORTIONS

The Fujix P401 Mini Video Projector lets you view images from a camcorder, VCR, or videodisc player two ways: When you want to review or scan images quickly, use the three-inch monitor on the unit's side panel. For presentations or family gatherings, use the projector to create up to 40-inch images. Price: $799.



WHAT'S NEW

CARRY THE MUSIC

The MiniDisc audio format made digital music portable, so it's only logical that a carrying case should follow. The $30 Lebo Voyager MD case holds the player plus eight mini discs; a separate pocket stows headphones. Lebo, Box 540, 80 Business Park Dr., Suite 207, Armonk NY 10504.

DOUBLE TALK

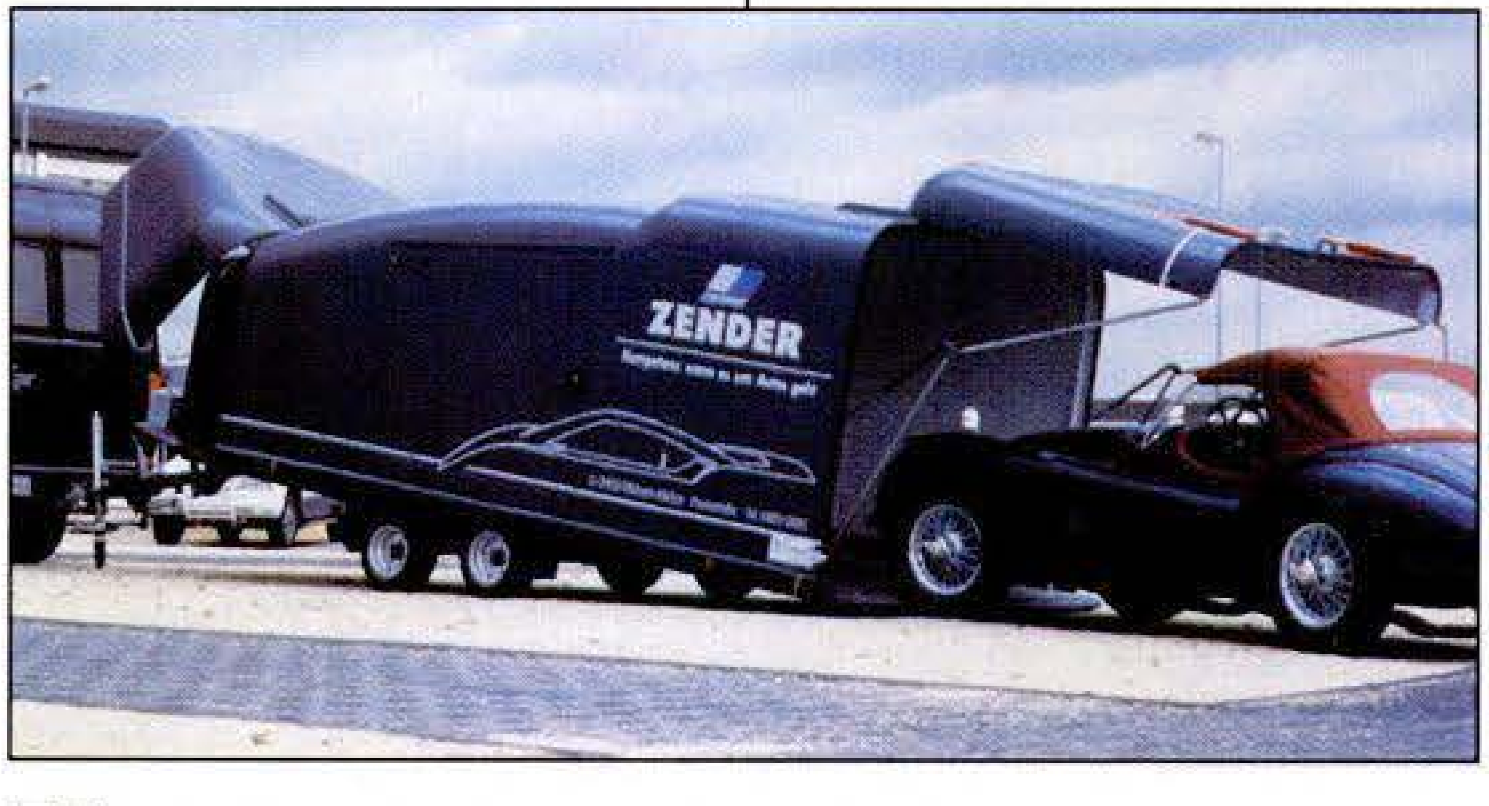
The base unit on Toshiba's FT-6503 cordless phone has its own keypad and built-in microphone so it serves as a stand-alone speakerphone and a portable two-way intercom. The phone also has ten-channel scanning, a digital security code, and speed dialing for both the base and handset. Price: $150.

POCKET ZOOM

Weighing just six ounces, Olympus's Infinity Stylus Zoom is extremely lightweight and compact. The $325 camera features a 35-to-70mm autofocus zoom lens plus all-weather capabilities—a waterproof seal prevents moisture from leaking in around the lens barrel. Its unique lens design enables you to snap sharp photos from as close as two feet.

WIND AND WEATHER

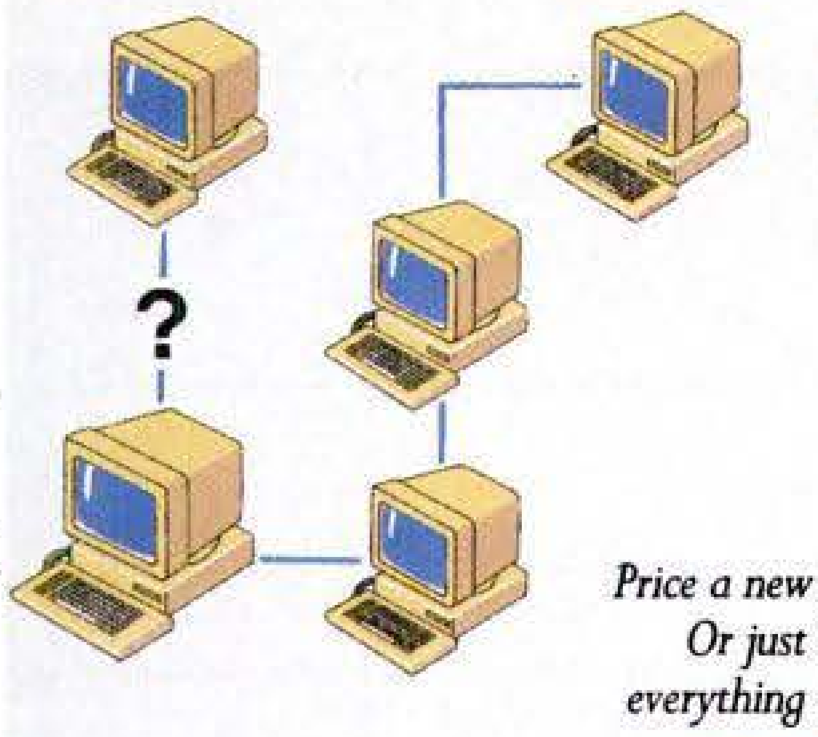
This portable unit displays wind speed and air temperature, making it handy for outdoor activities such as yachting, mountaineering, and skiing. Called Wind Messe, the device measures gusts as light as 0.2 meters per second and calculates strongest, lightest, and average wind velocities. Manufactured by Empex Instruments, the unit is sold in Japan.



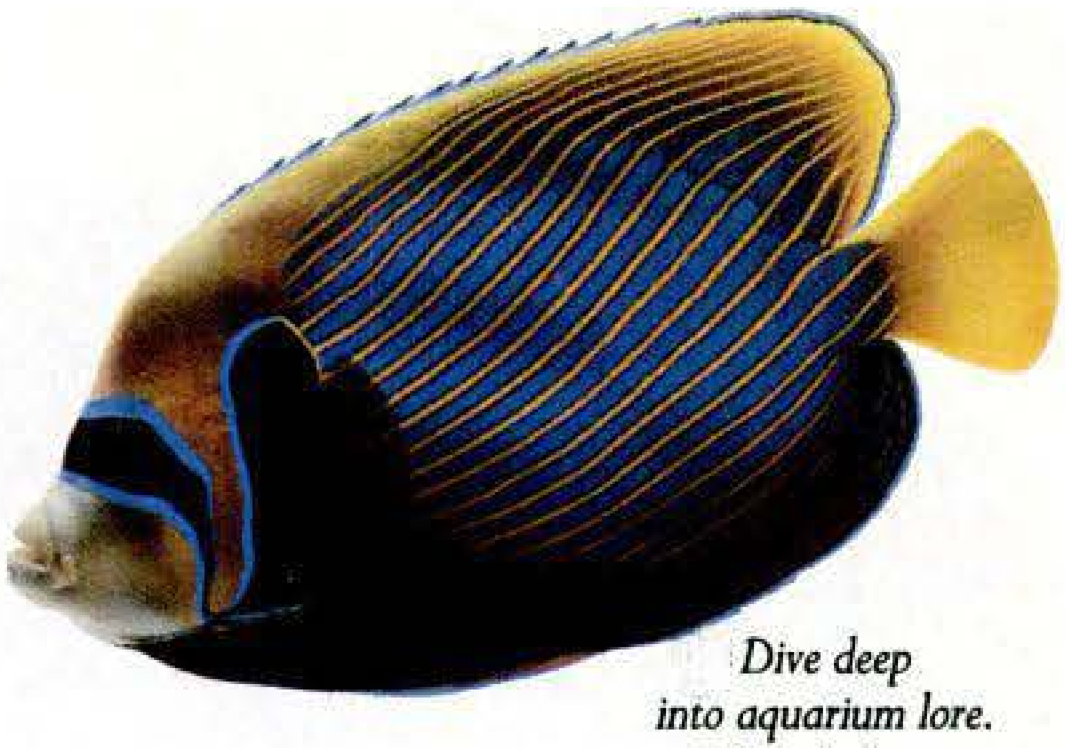
HIGH-SECURITY TRAILER

The aerodynamic Roll Safe protects rare, antique, or prototype automobiles from weather and theft. To ease loading, the glass-reinforced plastic container has a full-width rear hatch, and the rear of the trailer lowers hydraulically. Price: about $19,000. Zender, 5403 Mulheim-Karlich, Germany.

Find out why your PC won't talk to your LAN. And what you can do about it.



Shop. But don't drop. Need a 100% cotton pinpoint oxford shirt with button-down collar? In ecru? Try on our Electronic Mall.®

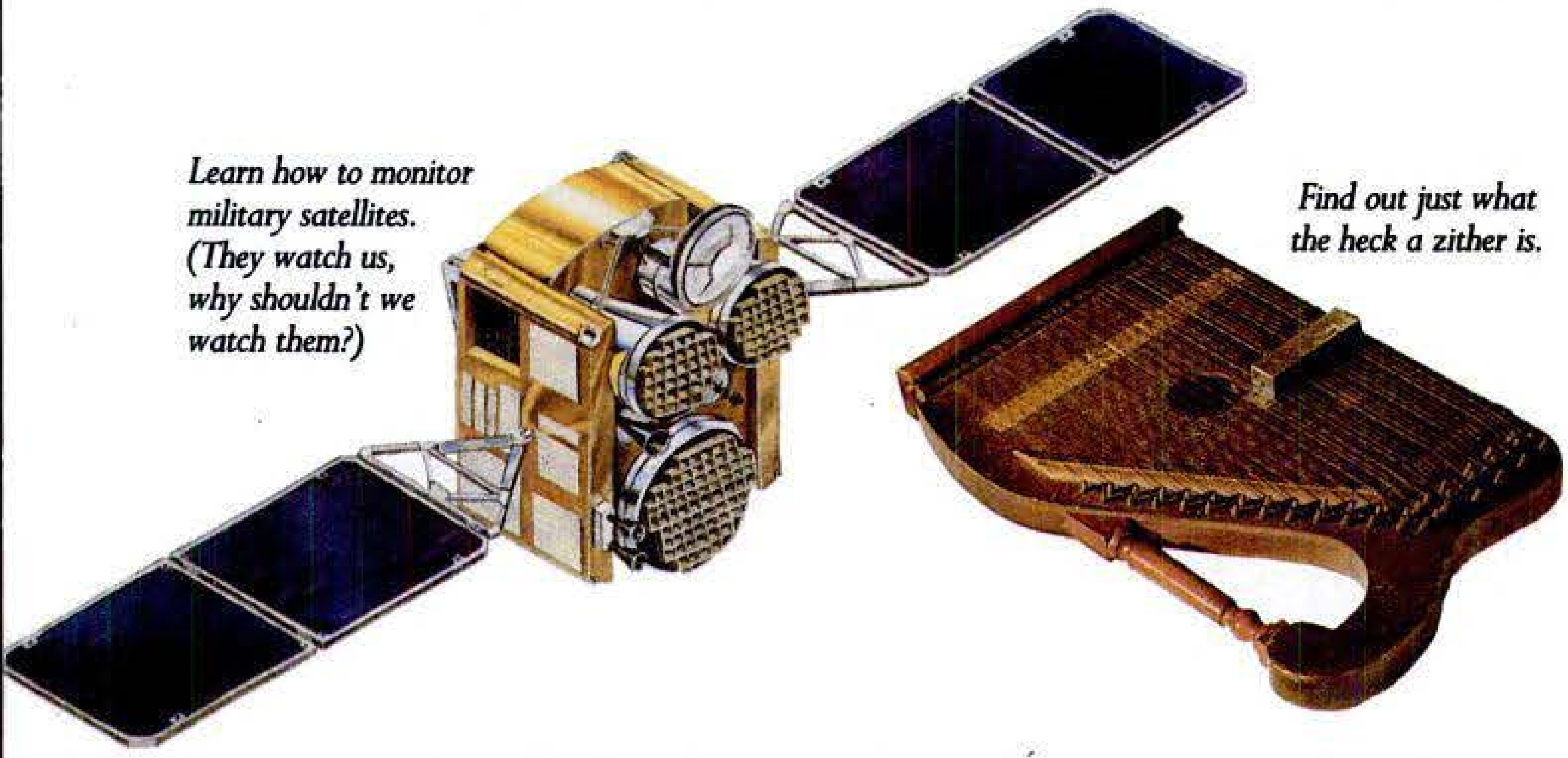


Dive deep into aquarium lore. Like whether a canister or protein filter is better for a 110-gallon salt-water tank.

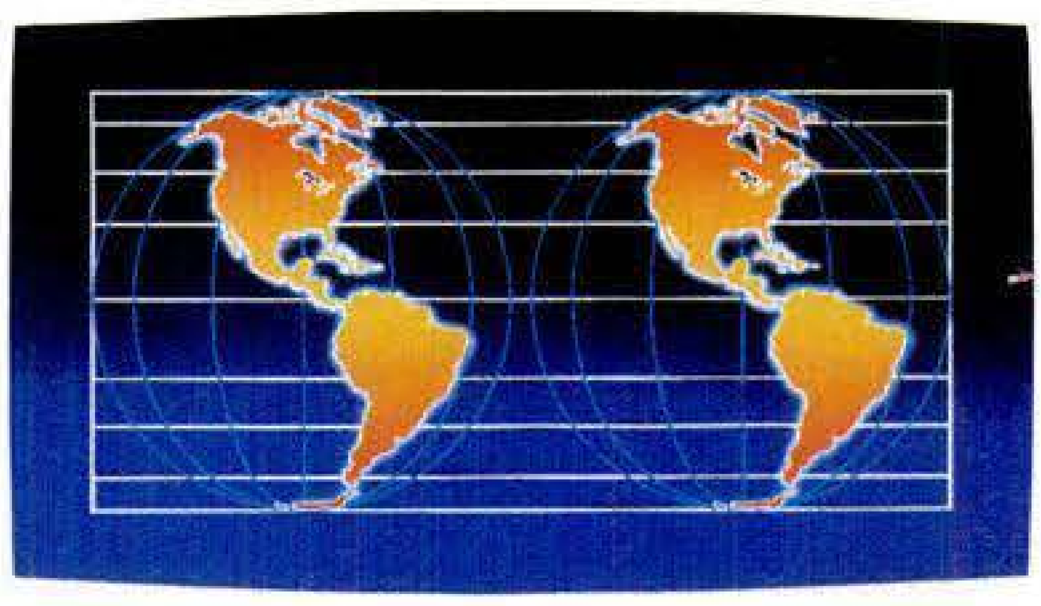
Price a new Mustang. Or just learn everything about it.

Finally, a computer information service you can't outgrow. No matter how hard you try.

Learn how to monitor military satellites. (They watch us, why shouldn't we watch them?)



Find out just what the heck a zither is.



Talk to twice as many people about parallel universes.

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For a low one-time membership fee of $8.95 a month, you can use our most popular services as often as you like: news, sports, weather, shopping, reference materials, our electronic mail service of up to 60 messages a month, and more. Plus, there's a whole universe of other, extended options available at nominal additional charges. Your first month on CompuServe will be free, and we'll give you a $25 usage credit to explore our extended services.

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Nissan Quest GXE

If it didn't handle like a car, this could have been a million dollar demonstration.

Suffice to say, there wasn't a single broken goblet. Not one busted bud vase. Not even so much as a chipped champagne flute.

There were, however, plenty of frazzled nerves as we drove the Nissan® Quest™ through an elaborate maze of some of the world's finest crystal (enough Waterford, Lalique and Orrefors to fill even the most ambitious bridal registry).

Of course, there was never any doubt on the part of our engineers, who designed the Quest to look, act and feel like a minivan, but to drive like an entirely different animal.

The first place they started was under the hood. Where you'll find a 3.0-liter, V6 engine similar to the one found in the Nissan Maxima® GXE. This, combined with front-wheel drive, gives the Quest uncanny responsiveness.

Important, whether you're merging with highway traffic or dodging wafer-thin water decanters.

The engineers also modeled the rack-and-pinion steering system after the Maxima. They adjusted the power assist, and then carefully tuned each element (bushings, bearings, and valves) to provide the driver with an optimal feel for the road surface.

To complete the equation, they gave the Quest a suspension system which, unlike the rear leaf-springs on many minivans, utilizes two special wide-design leaves that result in the kind of smooth ride you'd expect in, well you guessed it, the Nissan Maxima. They even added front and rear stabilizer bars* that help keep the Quest level through curves and sharp cornering.

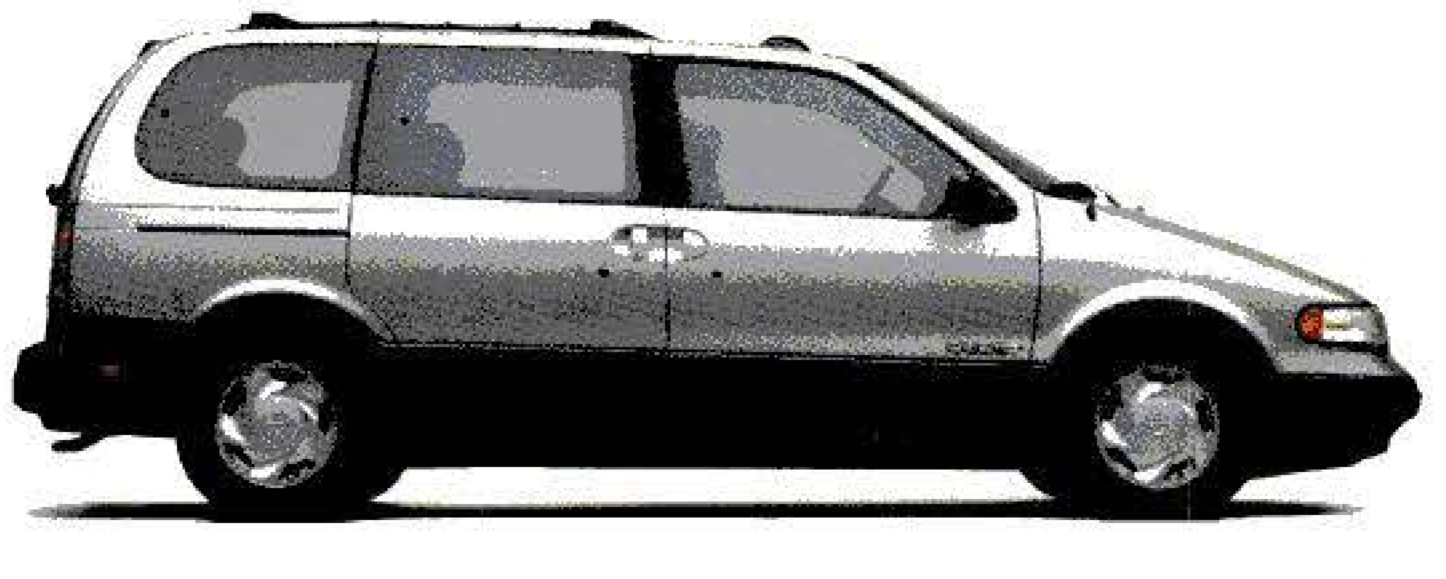
The result? The Quest doesn't handle like a car. It handles like a very good car.

A statement readily confirmed by any one of the twenty studio assistants who earned a day's pay without ever lifting a broom and dust pan.

If you're still skeptical you can take the Nissan Quest out for a test drive. But before you do, make sure you drive some other minivans. We're confident that after a fair comparison the difference will be, and you must have seen this coming, crystal clear.

For information call 1-800-NISSAN-3 ext. 217.

It's time to expect more from a minivan.™



*Nissan Motor Corporation U.S.A. Smart people always read the fine print. And they always wear their seat belts. *Optional rear stabilizer bar available with extra performance package. Waterford, Lalique and Orrefors are registered trademarks of their respective manufacturers. Model shown is the Nissan Quest GXE.*

MESSAGE CENTER

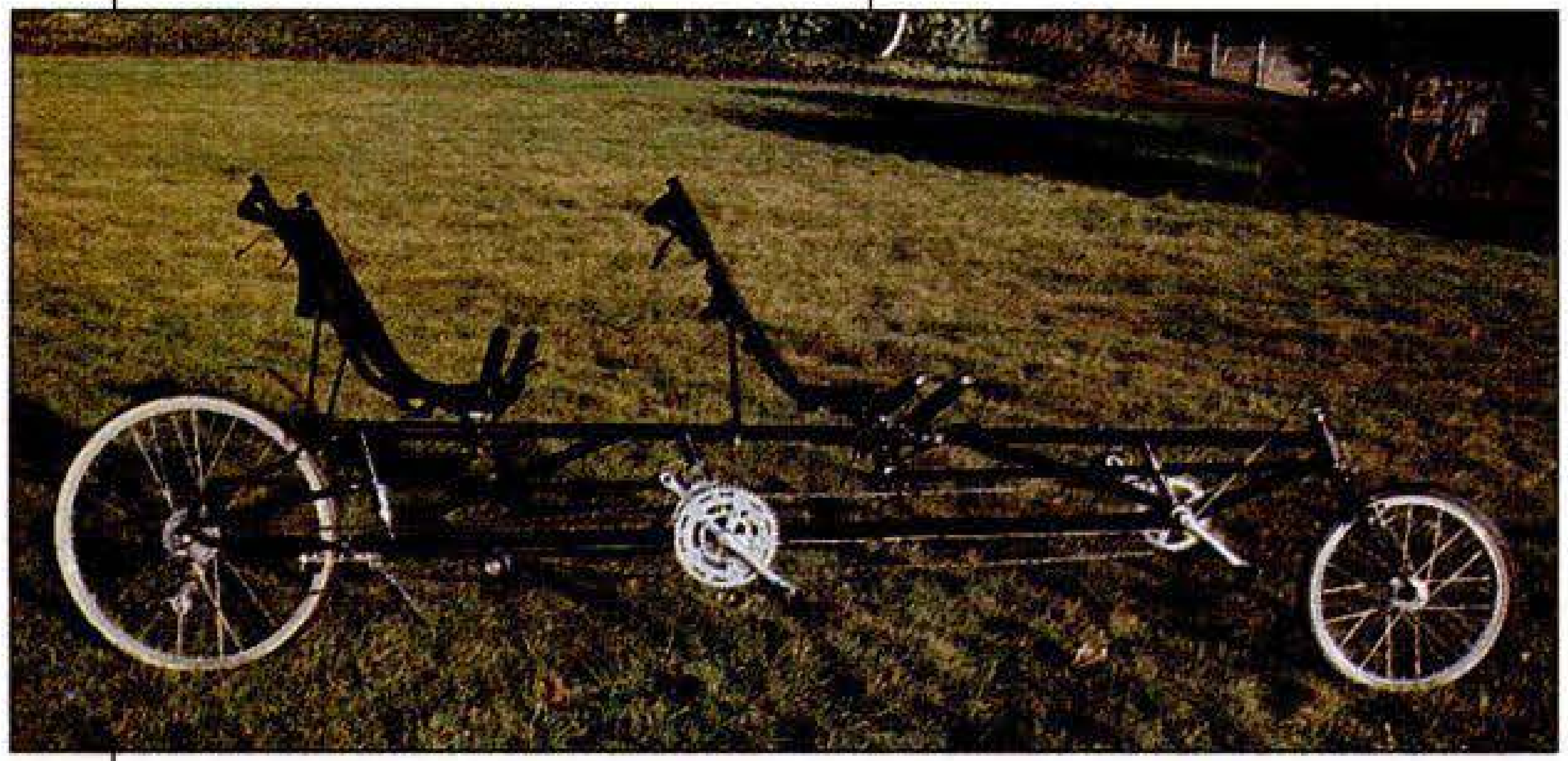
Forget the pencil and paper: Get the Message recording machine enables family members to leave electronic notes for one another. Press the smaller button to record a message up to ten seconds long; use the larger button for playback. Price: $29. With Design In Mind, 9660 Topanga Canyon Blvd., Chatsworth CA 91311.

ACE OF SPADES

The jagged edge of the Super Shovel makes it well-suited for penetrating hard-packed or rocky soil, roots, and clay. The head is made of 11- or 13-gauge tempered-carbon spring steel; two handle styles are available. The shovels cost less than $30. Lomar Enterprises, 1616 Chanute Rd., Peoria IL 61615.

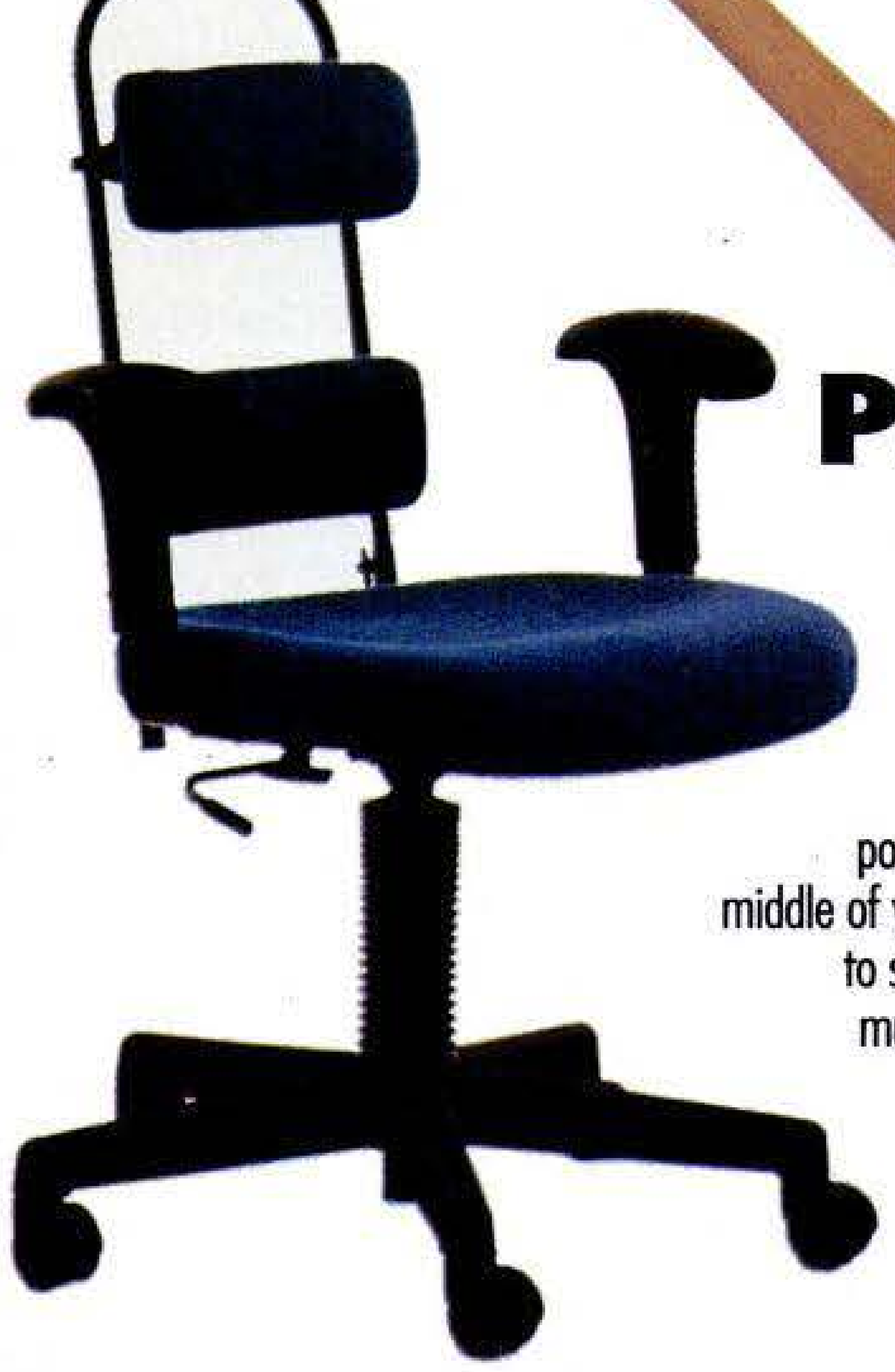
SPEED PLUS EFFICIENCY

The BMW M3, a performance version of the 3-series available only in Europe, offers more than quick acceleration (0 to 62 mph in six seconds) and speed (up to 155 mph) from its six-cylinder engine: Its power plant generates a record-breaking 95.7 hp per liter and 78.9 pound-feet of torque per liter. For greater emissions reductions, each of its two exhaust pipes—one per three cylinders—is fitted with oxygen sensors. The coupe gets 31 mpg.



RECUMBENT BUILT FOR TWO

The Fleetwood, a tandem *and* recumbent bicycle, has a streamlined frame measuring about 10.5 feet in length. The $3,100, made-to-order bike weighs 51 pounds. Ryan Recumbents, 3910 Stewart Rd., Unit F, Eugene OR 97402.

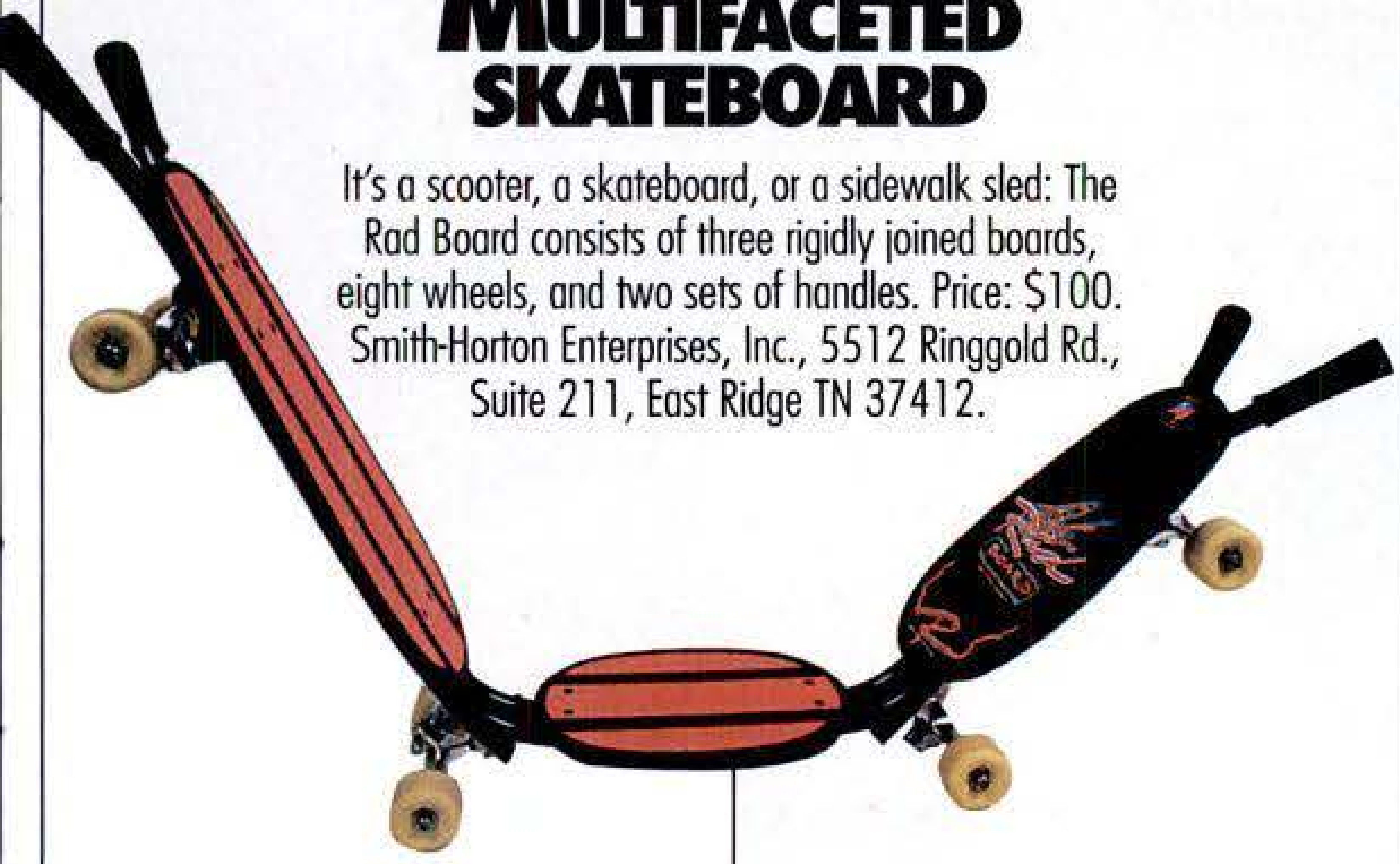


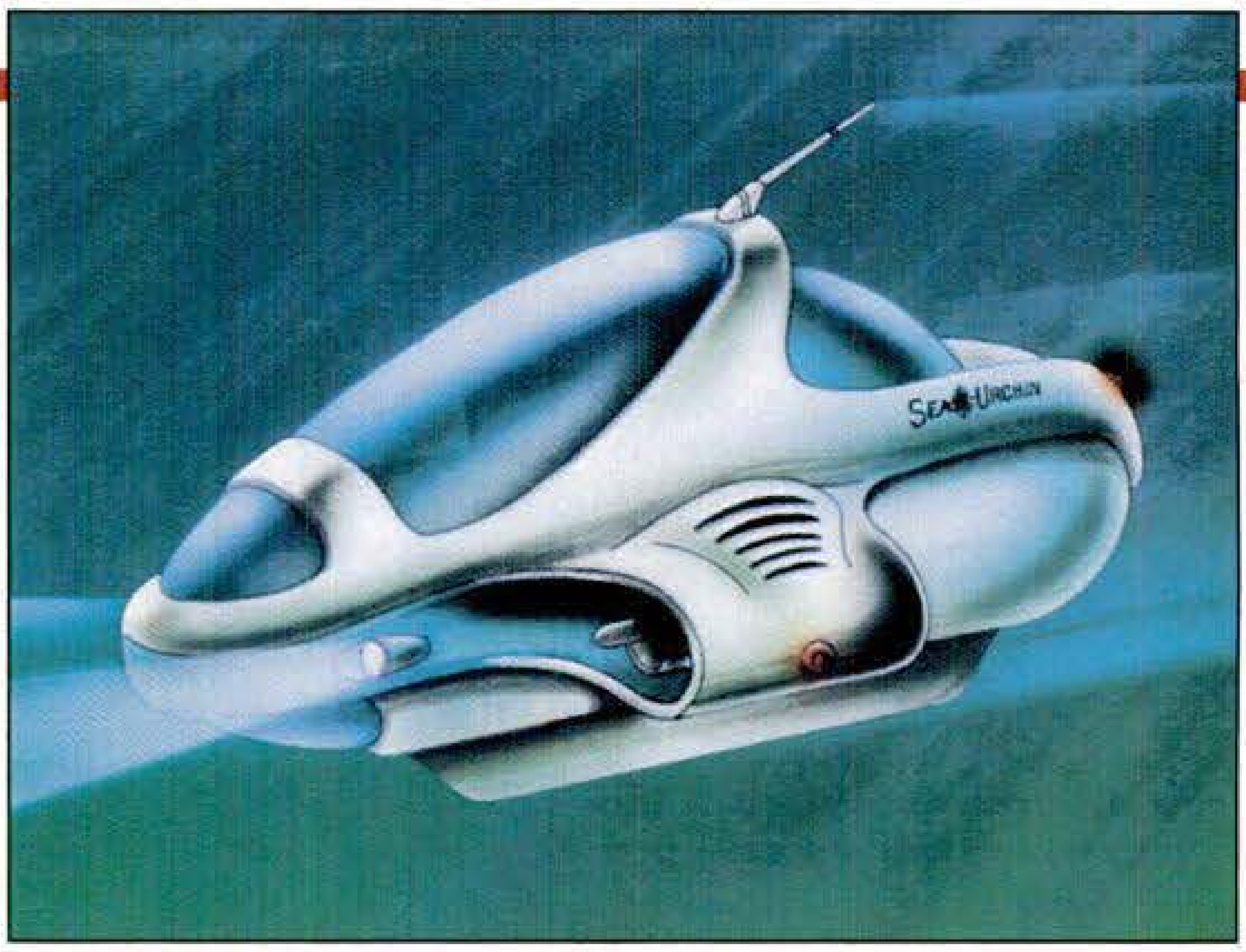
PUSHING POSTURE

Instead of supporting your lower back, the Zackback Computer Posture Chair uses two adjustable pads to support the base of your spine and the middle of your back. This design forces you to sit upright, helping to prevent the muscle strain that poor posture can cause. Price: $599. Zackback International, Box 9100, Rochester MN 55903.

MULTIFACETED SKATEBOARD

It's a scooter, a skateboard, or a sidewalk sled: The Rad Board consists of three rigidly joined boards, eight wheels, and two sets of handles. Price: $100. Smith-Horton Enterprises, Inc., 5512 Ringgold Rd., Suite 211, East Ridge TN 37412.





PERSONAL SUB

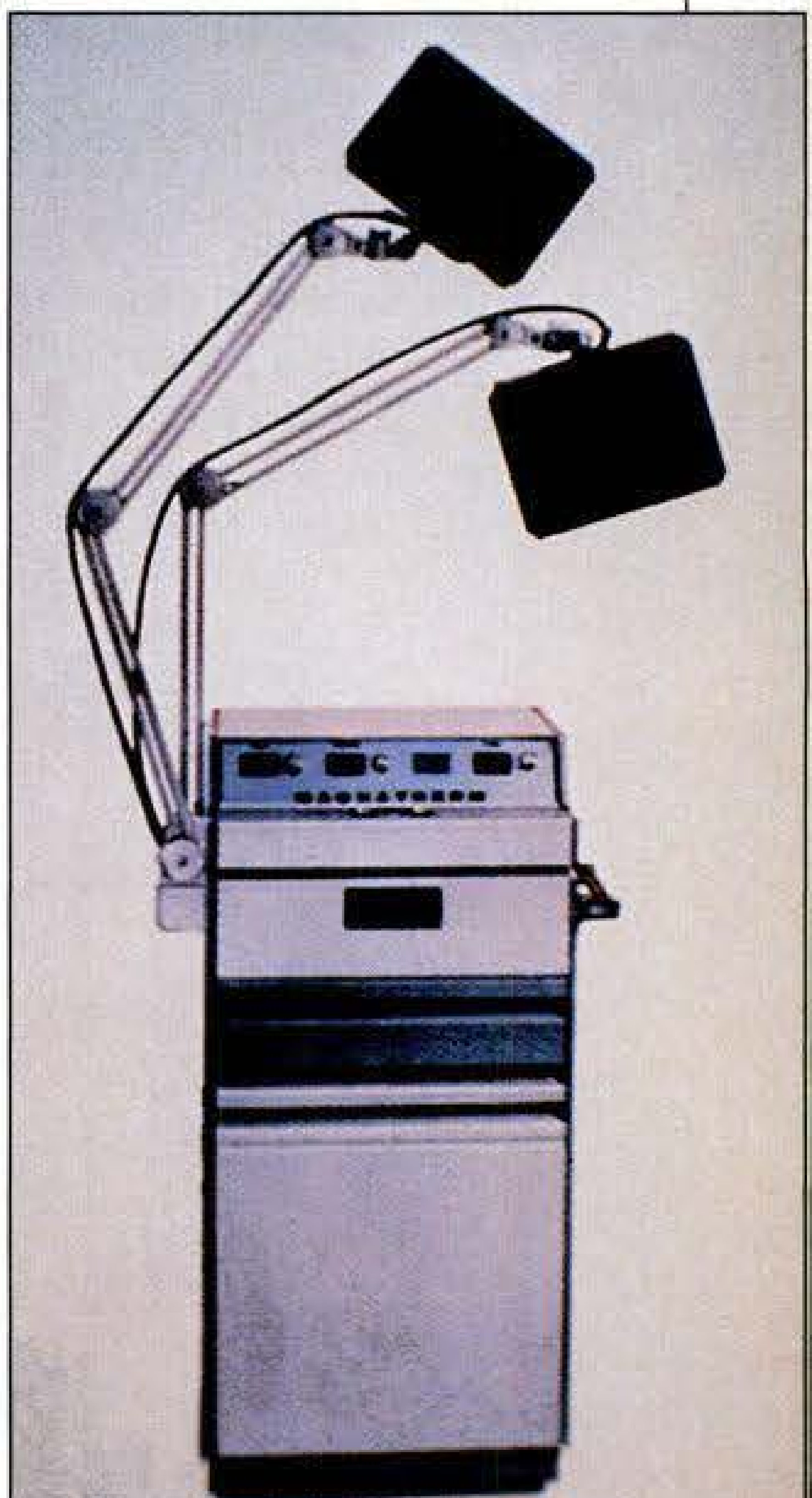
The Sea Urchin, a pressurized one-person submersible craft, operates on the surface or at depths down to 100 meters. Using two battery-powered thrusters to maneuver the vessel, the operator lies in the tiny sub and views the seabed through a bubble window. Price: $50,000. Sea Urchin Submersibles, 4534 W. 1st Ave., Vancouver, B.C. V6R 1H8, Canada.

FIRE-RESISTANT FOAM

Made of expanded obsidian glass, Pyrofoam insulation material withstands temperatures approaching 2,000°F. The insulation can be ordered as pipe wrapping or in panels of varying sizes. R-value data is not available. Pyrofoam Inc., Route 14, Box 2337A, Kennewick WA 99337.

VISIBLE VOLVO

Yard-long taillights and luggage space are distinguishing features of the Volvo 850 station wagon. With the rear seats down, the cargo room can be expanded to 55.8 cubic feet; for loads up to nine feet long, the front-passenger seat folds flat too. Like the sedan, the front-wheel-drive vehicle is powered by a 2.5-liter, five-cylinder, 170-hp engine.



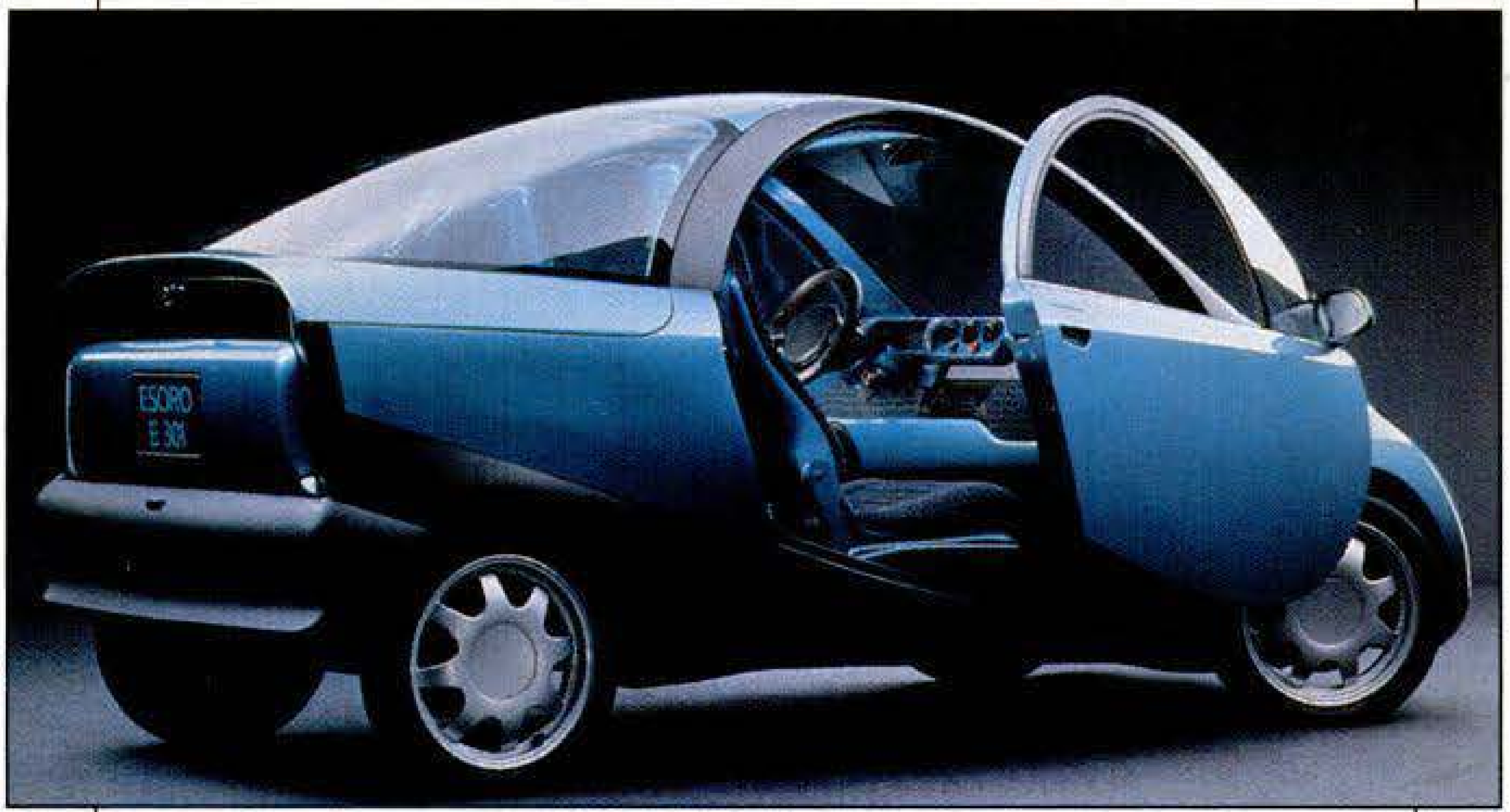
SMART THERAPY

Magnatherm's two Smart Arms, or treatment heads, lock into place after being positioned on a patient's body. Through the arms, a pulsed electromagnetic current helps speed the healing of sprains, strains, and other musculoskeletal injuries by improving blood flow, oxygenation, and metabolic rate. International Medical Electronics, 3839 Broadway, Kansas City MO 64111.

WHAT'S NEW

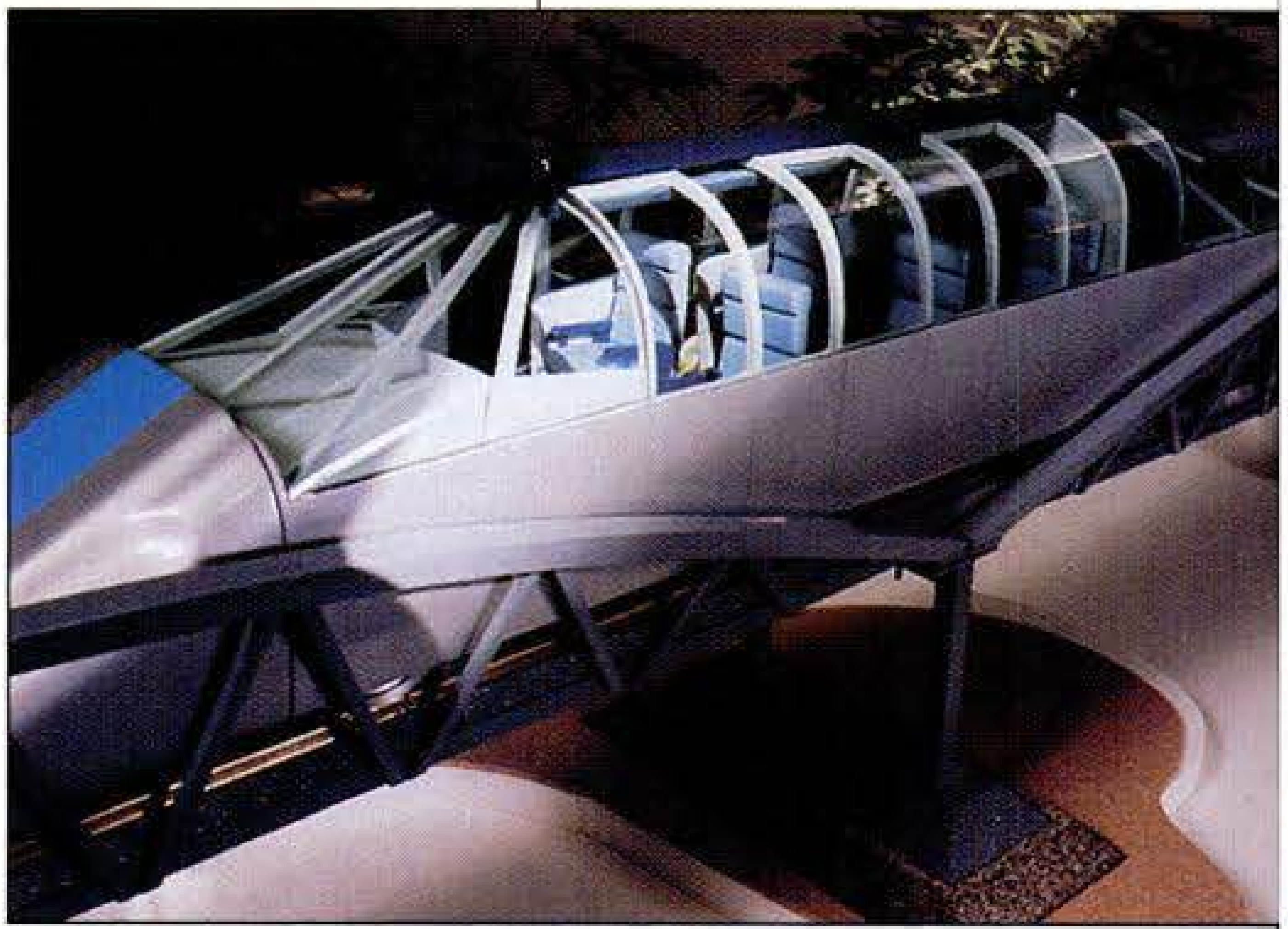
PUFF-UP ENVELOPE

The self-inflating Xpander Pak protects fragile items during shipping. To use, puncture the outer layer on both sides; inside, the vacuum-packed compressed polyurethane foam expands and conforms to the shape of the contents. Available in three standard sizes, the envelopes cost about $3 each. Moore, 275 N. Field Dr., Lake Forest IL 60045.



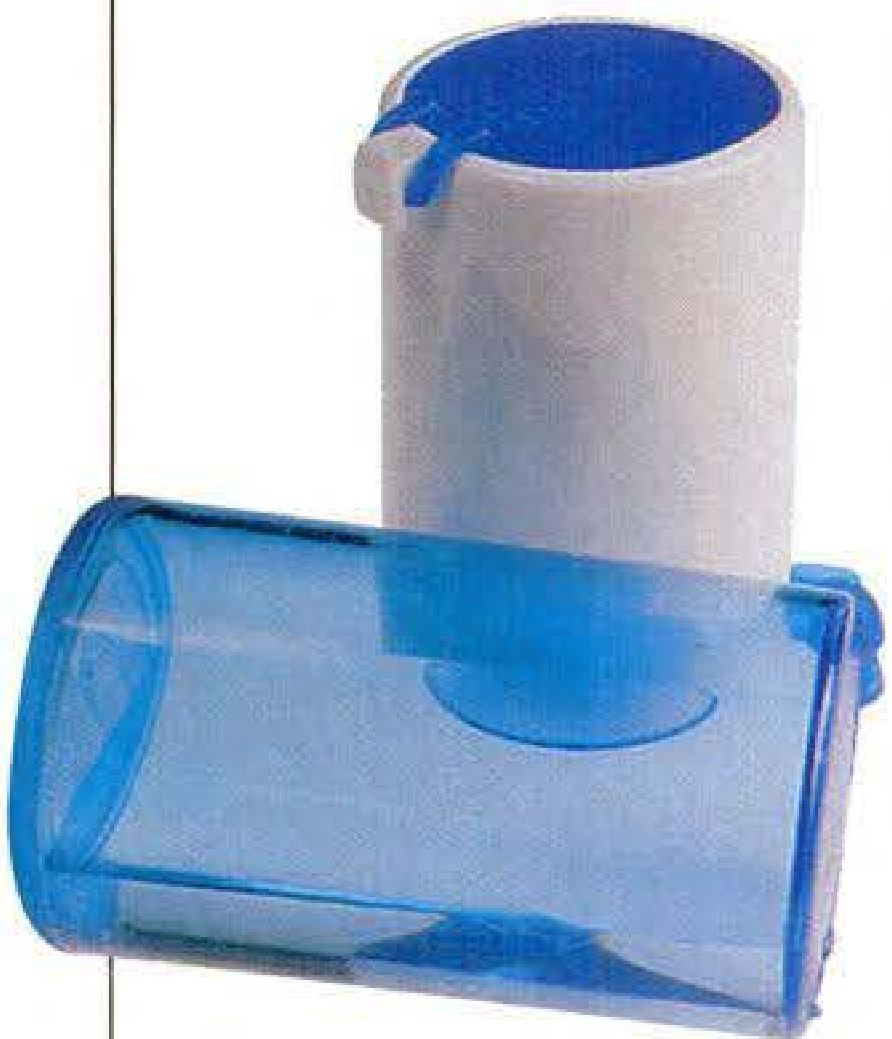
FEATHERWEIGHT

The Swiss Esoro E301 electric vehicle weighs just 1,365 pounds, including a 570-pound nickel-cadmium battery pack that gives it a 90-mile range. It is powered by a 28-hp, high-speed, alternating-current induction motor and has a top speed of 75 mph. For safety, the frameless body has a rigid passenger compartment with a frontal crush zone, reinforced sills to resist side impacts, and dual air bags.



SPEEDY TRANSPORT

The CyberTran, developed by the Idaho National Engineering Laboratory, is a prototype lightweight electric transportation system that could be a viable alternative to other proposed high-speed systems ["Rapid Rails," June '92]. Each 36-foot-long, computer-controlled vehicle would carry as many as 24 passengers, traveling 60 mph in urban areas and 150 mph between cities. In addition, CyberTran would cost just 10 to 20 percent of conventional rail systems.



SPILL STOPPER

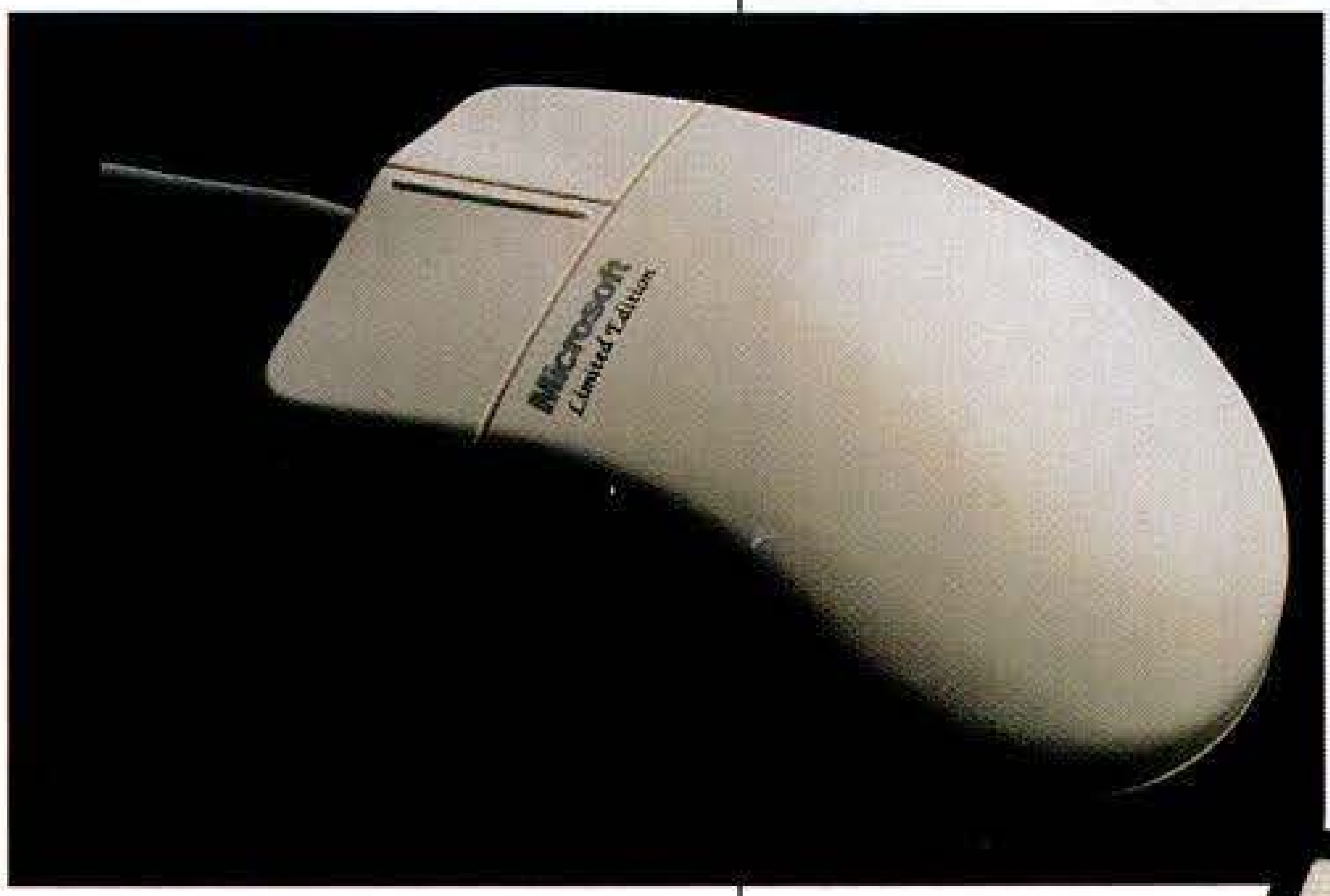
A hinged cover on this drinking cup prevents spills. As you drink, you push the cover inward; if you tip the cup, the liquid forces the cover closed, forming a seal at the rim. The cups come in white or translucent blue and cost $20 for a set of six. Deakon Enterprise, Box 129, Montreal H1H-52L Canada.

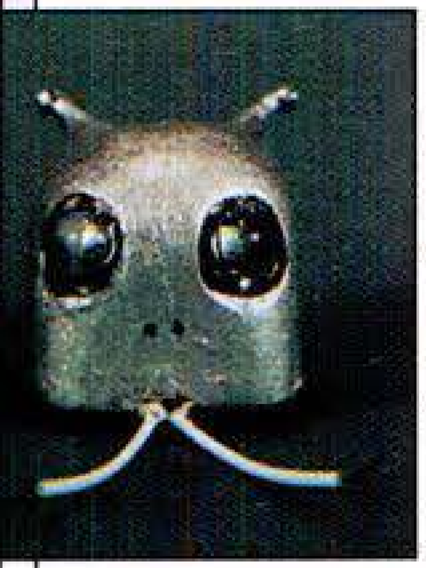
DUPLICATION DEVICE

The Casio CP-1000 board copy reproduces images from blackboards, overhead displays, or slide projectors. Combining a camera and copier, the 4.2-pound portable device has built-in autofocus and autoiris features. To use, point the $795 machine at a blackboard and press a button; a black-and-white, thermal-paper copy is produced in a few seconds.

MIGHTY MOUSE

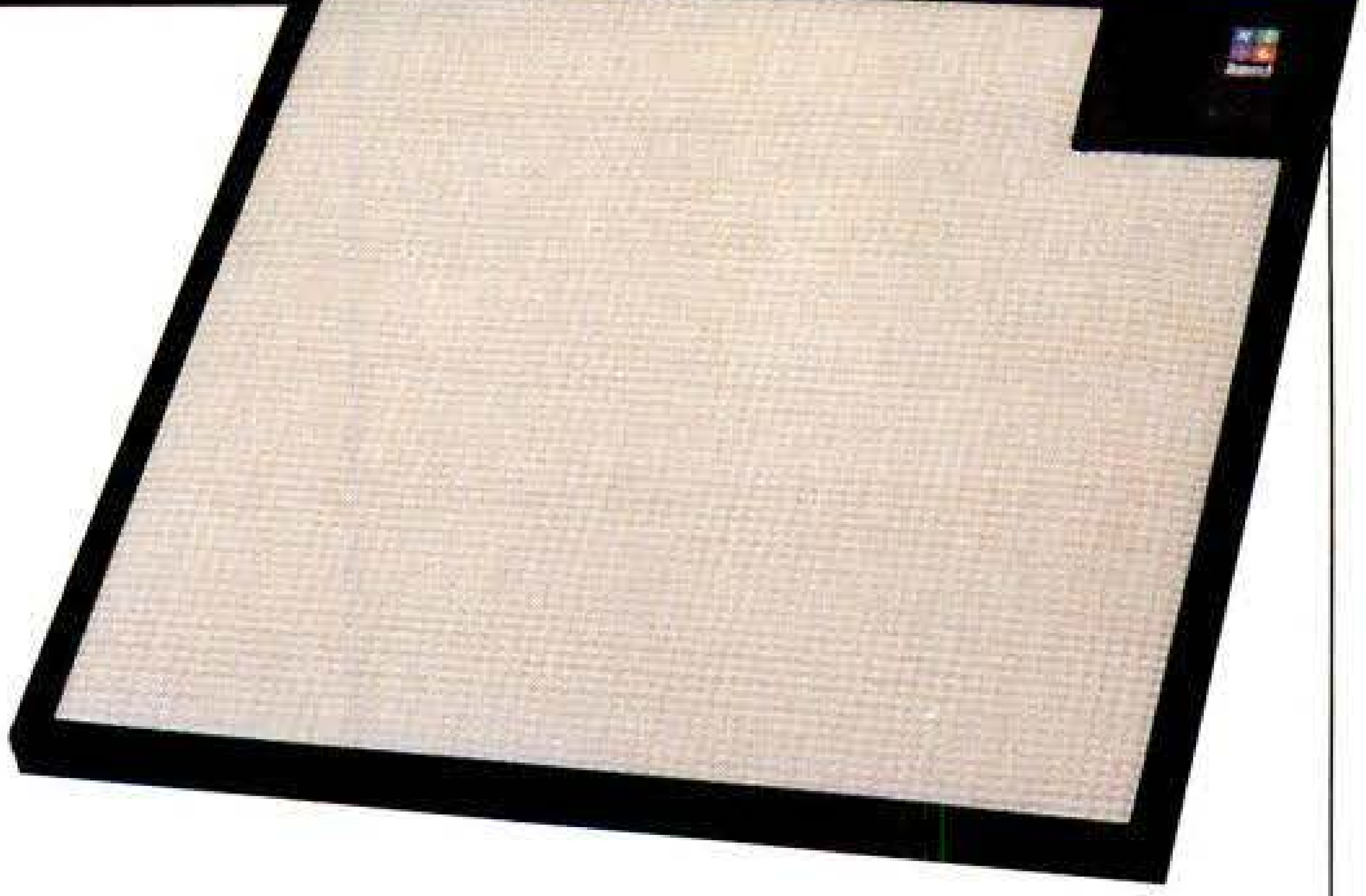
Microsoft's redesigned computer mouse has a more ergonomic shape and offers advanced software features. These include orientation (to designate any direction of movement); magnify (to help place the cursor); locate (to help find the cursor); and snap-to (to send the cursor to the most frequently used selection on the menu). Price: $125.





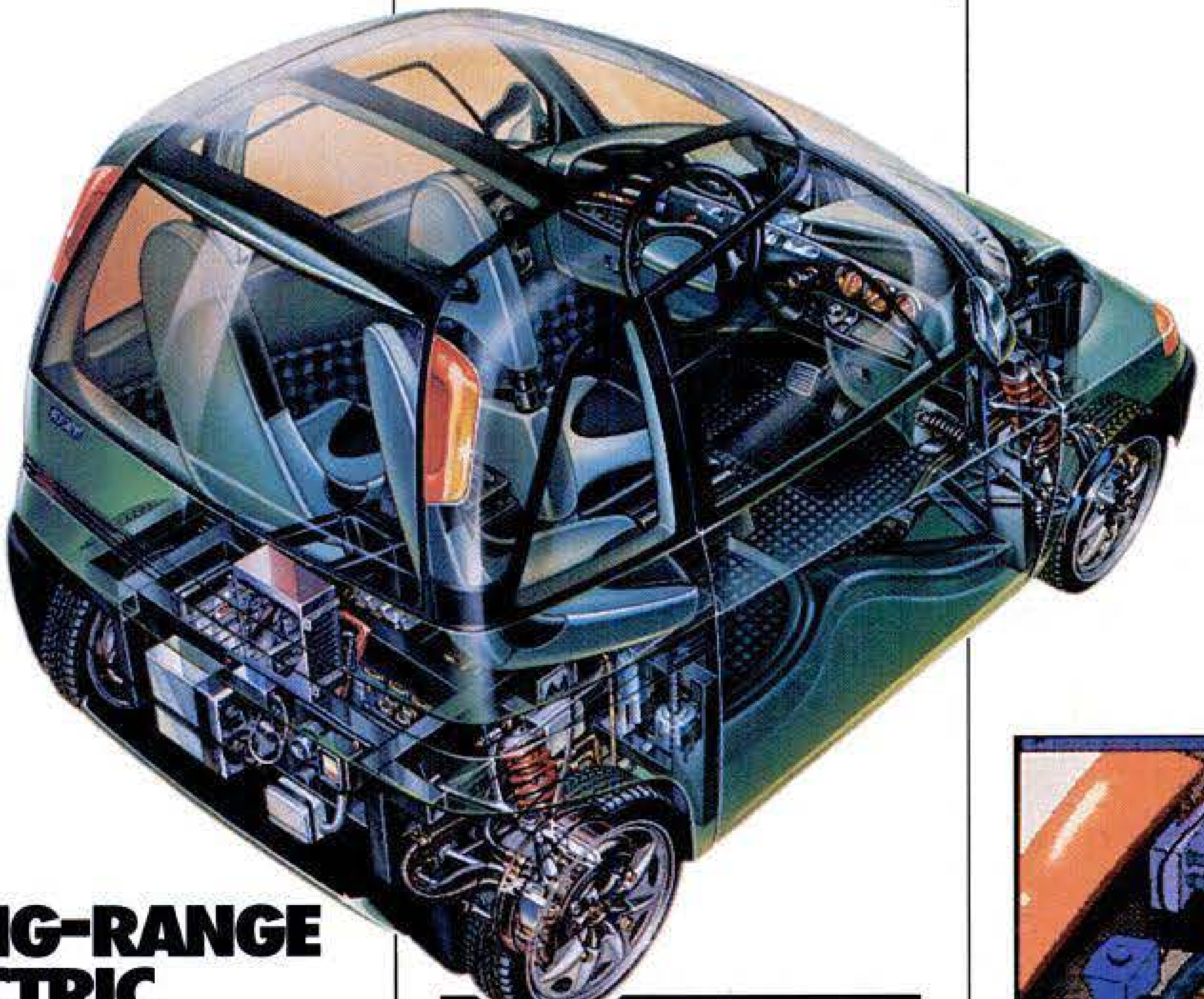
TOM THUMB ROBOT

Shown approximately its actual size, the EM10A is the world's smallest autonomous robot, according to manufacturer Seiko Epson of Japan. The self-propelled machine measures 0.49 by 0.43 by 0.43 inches, has a motor with a 0.04-inch rare-earth magnet rotor, and is directed by a four-bit computer chip. The robot could be used to inspect pipes and other hard-to-reach locations.



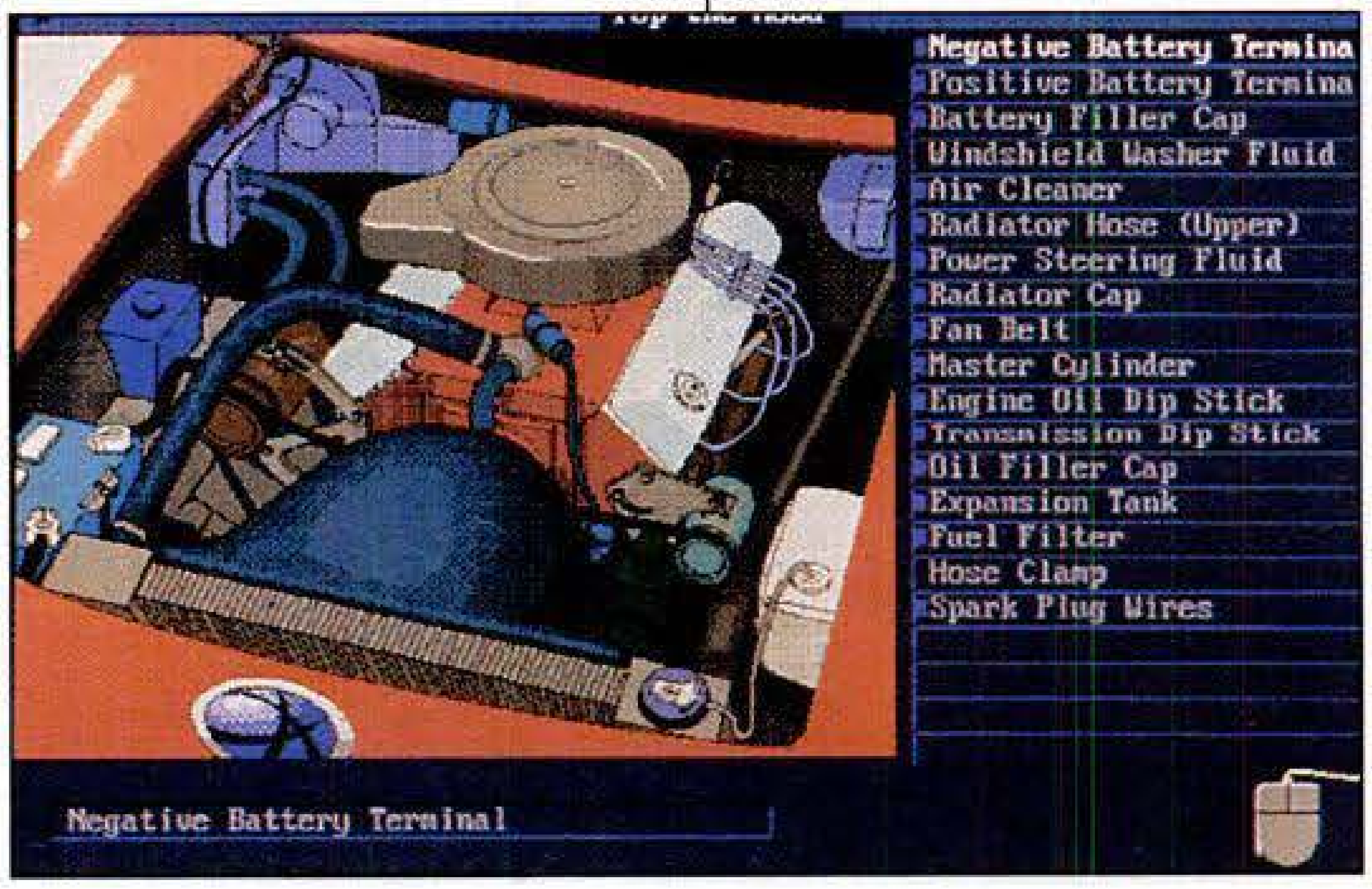
SMOKE SIGNALS

The System 4 air filter features a battery-powered smoke detector that, when triggered, shuts off your home's ventilation blower to slow the spread of smoke through the duct work. An audible signal lets you know when the filter requires cleaning. The $300 device must be installed professionally. System 4, Box 27175, 3874 Virginia Ave., Cincinnati OH 45227.



LONG-RANGE ELECTRIC

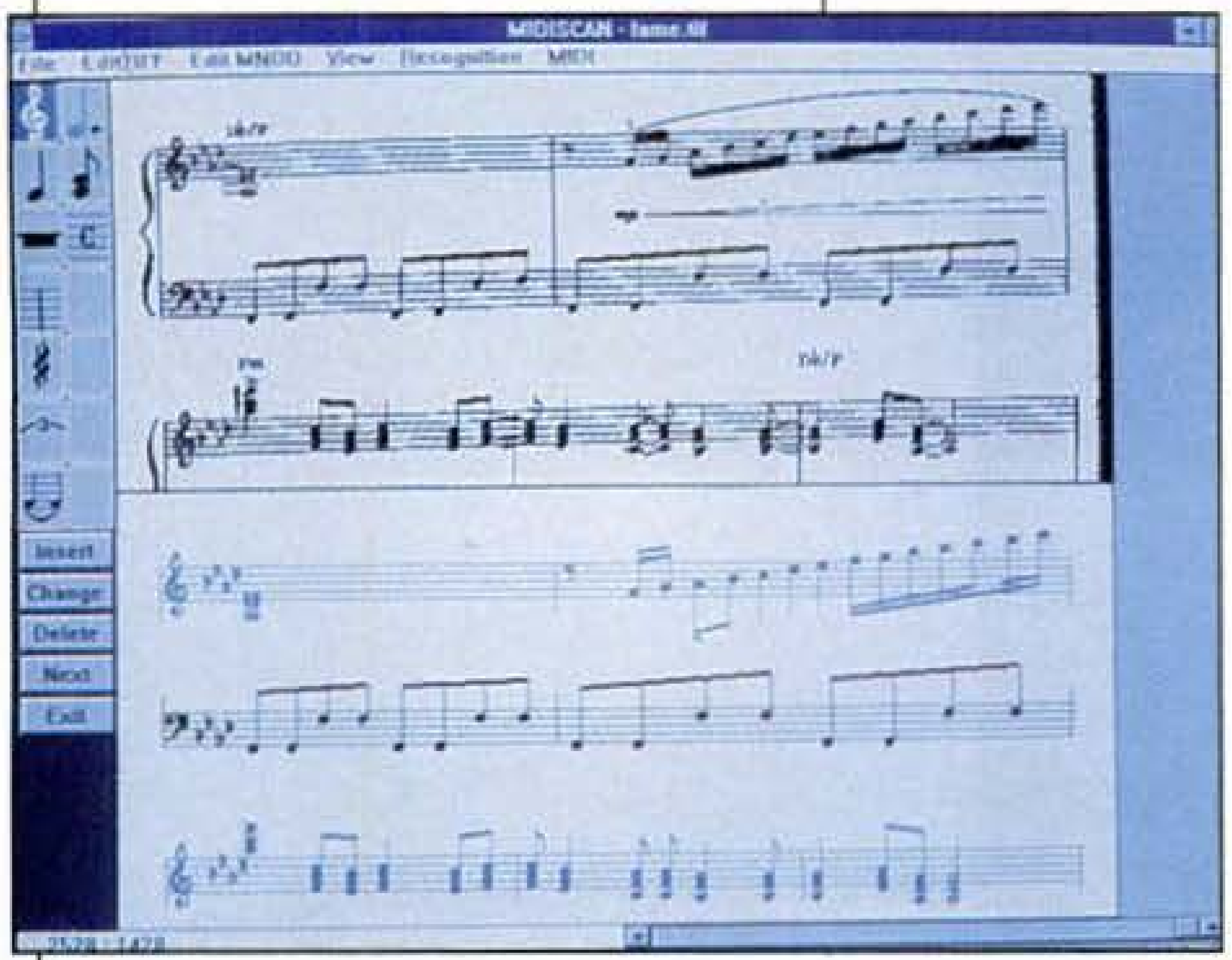
To trim this electric car's transmission losses, Fiat equips each rear wheel with a 9.5-hp alternating-current motor, drum brake, hub bearing, and suspension mounts. The concept vehicle has a sodium-sulfur battery pack that provides twice the range of a nickel-cadmium battery and four times that of lead-acid for a range of 186 miles at 31 mph and a top speed of 62 mph.



COMPUTER CAR REFERENCE

Get bumper-to-bumper knowledge of automotive systems and parts with Auto Insight, a PC software program. It features detailed zoomable illustrations, animations, in-depth explanations, games, and trivia. Price: $80. Informative Graphics, 706 E. Bell Rd., Suite 207, Phoenix AZ 85022.

WHAT'S NEW



MUSICAL INPUT

MIDIScan for Windows, the first music-reading software for scanners, converts printed music into a MIDI file, a standard computer format for music. After a MIDI file has been created, the musical score can be edited and played back via any MIDI sequencer or sequencer program. Price: $379. Musitek, 410 Bryant Circle, Suite K, Ojai CA 93023.

EXTENDING THE ELECTRIC

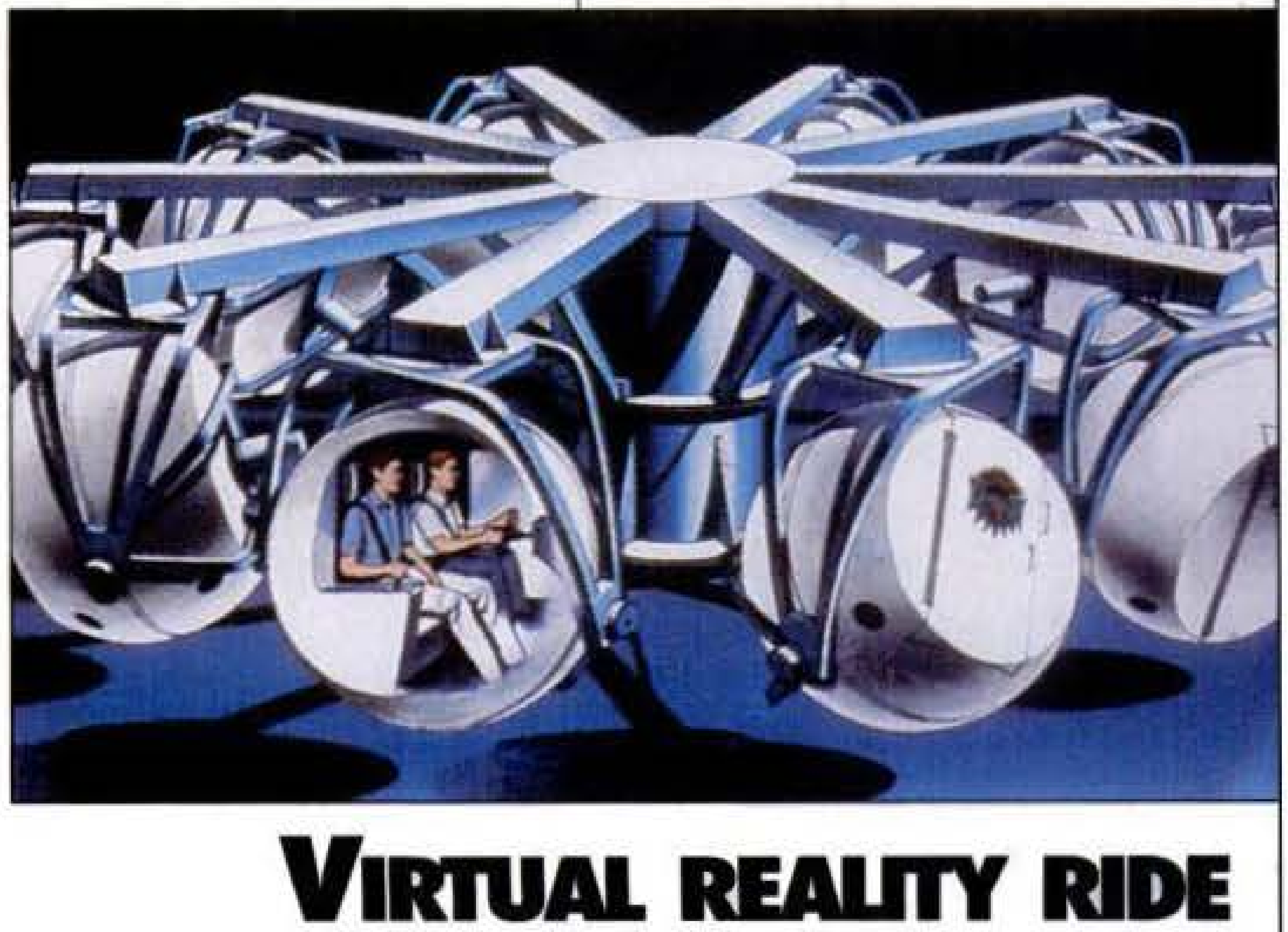
An improved sodium-nickel-chloride battery gives the Mercedes-Benz 190 electric sedan more power than previous versions. Mounted in the trunk, the battery produces 152 volts and is rated at 25 kilowatt-hours, enabling this car to reach speeds of up to 68 mph and have a range of 112 miles.

PENNY-PINCHER'S PRINTER

The Primera Color Printer costs just $995—less than one-third the price of other high-performance color thermal transfer printers. How? Primera uses the Windows software on your PC to perform page layout computing tasks instead of having a high-powered processor and font software. A 486 processor with four megabytes of expanded memory is recommended. Fargo Electronics, 7690 Golden Triangle Dr., Eden Prairie MN 55344.

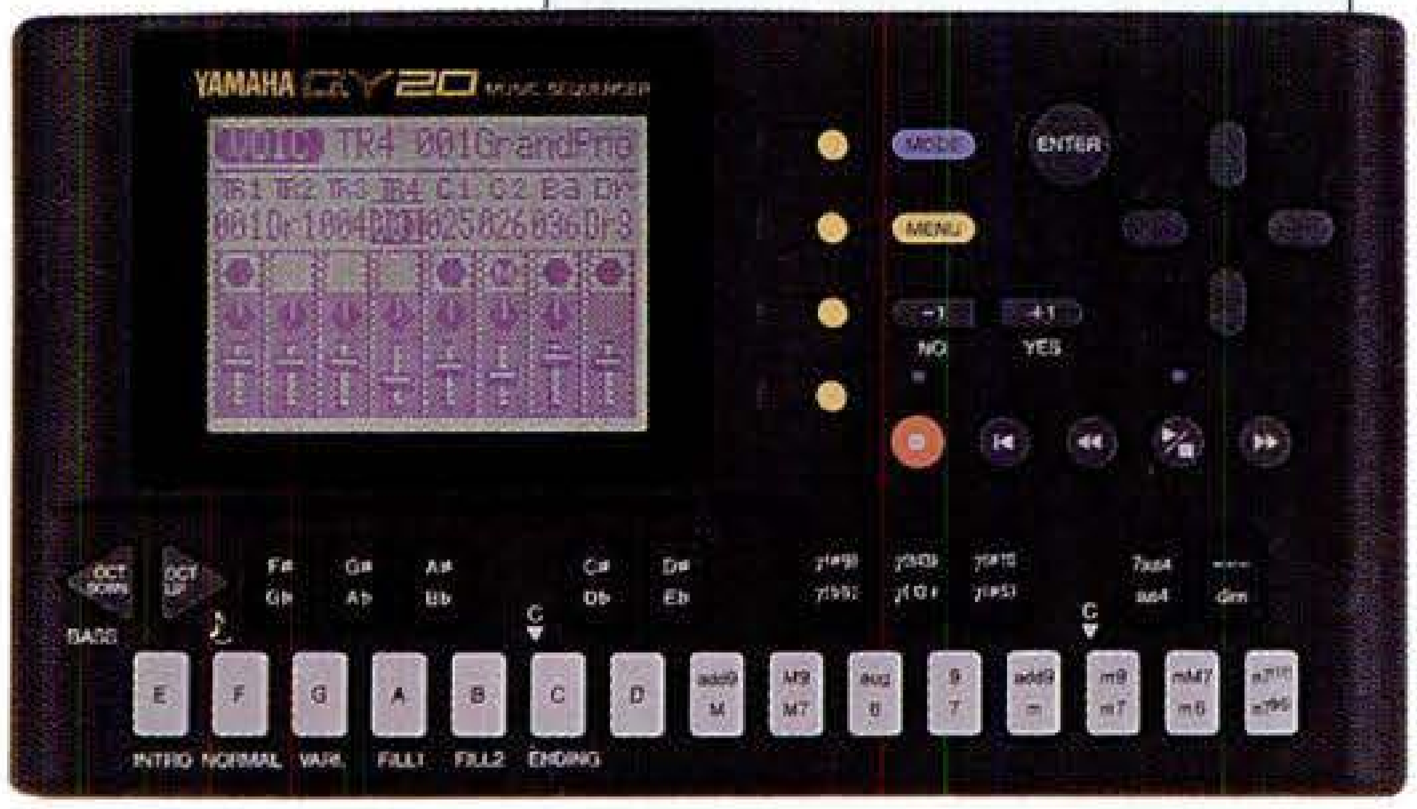
TALKING MAP

Nomad, a computer-controlled teaching tool, has a touch-sensitive pad that makes maps and diagrams accessible to visually impaired persons; the graphics are raised lines that can be programmed at numerous points with spoken messages. For example, touch a city on a map to hear its name; press again and hear historical details. Price: $975. American Printing House for the Blind, Box 6085, Louisville KY 40206-0085.



VIRTUAL REALITY RIDE

The Chameleon, a new amusement park ride due out this summer, capitalizes on virtual reality technology. Inside each pod, three-dimensional images are projected on a 30-by-52-inch screen; as you control the speed, direction, and outcome of each ride, you experience realistic g-forces created by the pod's movement.



MOBILE MUSIC MAKER

The Yamaha QY20 music processor is the next-generation QY10 music composing, editing, and producing system ["Best of What's New," Dec. '91]. The $599 device features expanded functions of the QY10: 100 voices, 8 drum kits, and a 20-song (or 28,000-note) storage capacity in 16 megabytes of ROM. Users can employ either the QY20's microkeyboard or an external keyboard that connects via a "MIDI in" port.

A TERMINAL WITH FLEXIBILITY

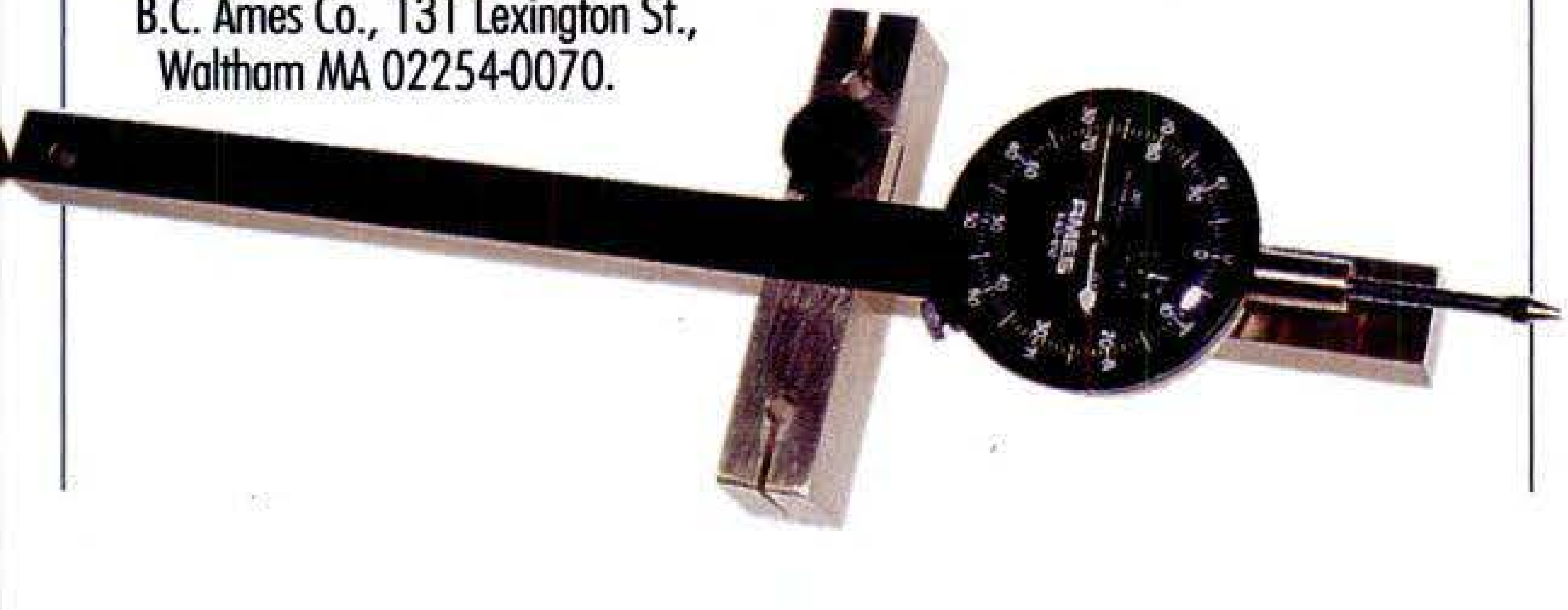
MAX/it video display terminals have the expandability of a personal computer. The key: two PCMCIA 2.0 slots. One card holds the terminal configuration with local video RAM, communications programs, and other on-site requirements. The second slot is available for the many new applications for this format, including modems and flash memory cards. LINK Technologies, 46595 Landing Pkwy., Fremont CA 94538.

THE PRICE IS NO TYPO

A *$26,000* mountain bike? That hefty price tag is due to the material the frame is built with: beryllium. A rare element, beryllium has a stiffness-to-density ratio superior to other metals. The result is a two-pound bike frame that is as durable as its four-pound aluminum cousin. American Bicycle Manufacturing Corp., 3102 S. Roosevelt Rd., Box 1245, St. Cloud MN 56302.

EXACTITUDE

You can check the accuracy and alignment of power tools with the Infinitii measuring device. For example, the spring-loaded arm enables you to precisely set the angle of a table saw blade or confirm the alignment of a saw fence. The $150 brass tool indicates measurements to within 0.001 inches or $^{1}/_{18}$ degree. B.C. Ames Co., 131 Lexington St., Waltham MA 02254-0070.



BABY HATCHBACK

Just 12 feet long, the British-built Nissan Micra has big-car features such as antilock brakes, hydraulic power steering, and a sunroof. An available 1.0- or 1.3-liter twin-cam 16-valve engine drives through an optional continuously variable transmission with a computer-controlled clutch that eliminates cold-start creep at idle.

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SCIENCE & TECHNOLOGY

EDITED BY DAWN STOVER

MILITARY TECHNOLOGY

STEALTHY SURVEILLANCE

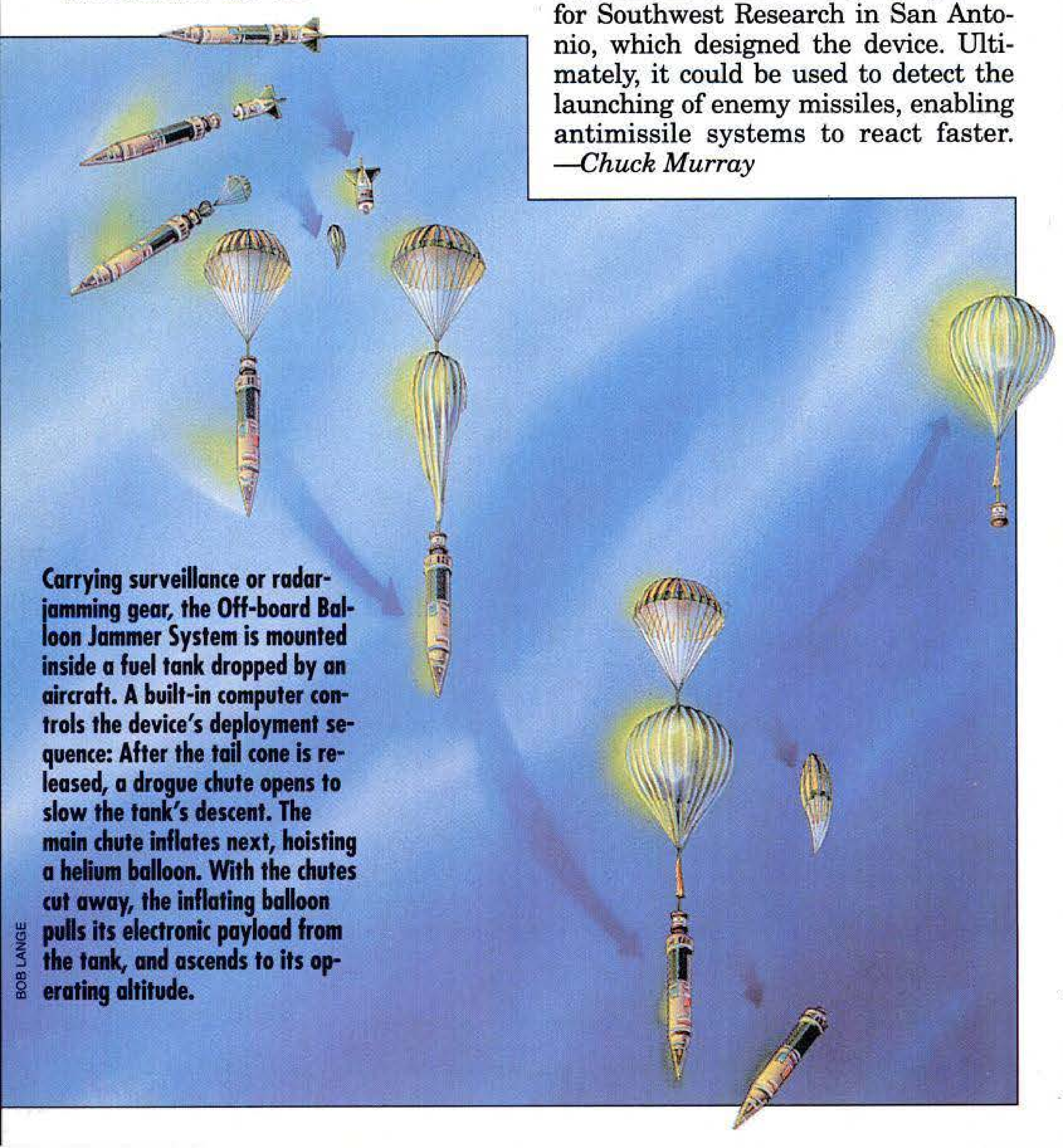
Dangling from a computer-controlled helium balloon, military surveillance equipment can now operate in hostile territories for hours at a time. The new concept, known as the Off-board Balloon Jammer System (OBJS), promotes safety for military aircraft crews and allows the surveillance equipment to remain in place over longer periods than have been previously possible.

Until recently, surveillance equipment and radar jammers typically were placed on military aircraft. Pilots then flew the aircraft into hostile territories and circled.

In contrast, the OBJS requires pilots to make only a single pass through hostile territory. A prototype version, mounted inside the external fuel tank of an F-111 military aircraft, is dropped from an altitude of 30,000 to 33,000 feet.

After the OBJS is released, a rugged spacecraft computer aboard the device controls the deployment of its subsystems. The computer sends a signal to pyrotechnic bolts, which fire to release the fuel tank's tail cone. This initiates a series of deployments as the tank sails earthward: A drogue parachute slows the unit. Then the main parachute inflates, extracting the helium balloon. Tiny guillotine devices cut the chutes away. After a five-minute inflation period, the 26-foot-diameter balloon pulls the electronic payload from the tank, which falls to Earth. The balloon and payload drop to an altitude of 14,000 feet before the tank is jettisoned, then slowly float back to 27,000 feet, where they can remain for four to six hours.

Designed for the Department of Defense's Joint Electronic Warfare Center in San Antonio, Texas, the system is said to be difficult to detect. "The OBJS makes a very small radar target," says William D. Perry, assistant department director of space systems for Southwest Research in San Antonio, which designed the device. Ultimately, it could be used to detect the launching of enemy missiles, enabling antimissile systems to react faster.
—*Chuck Murray*



Carrying surveillance or radar-jamming gear, the Off-board Balloon Jammer System is mounted inside a fuel tank dropped by an aircraft. A built-in computer controls the device's deployment sequence: After the tail cone is released, a drogue chute opens to slow the tank's descent. The main chute inflates next, hoisting a helium balloon. With the chutes cut away, the inflating balloon pulls its electronic payload from the tank, and ascends to its operating altitude.

BOB LANGE

SPACE EXPLORATION

THE ONCE AND FUTURE SPACEMAN

BY SANDY FRITZ

Buzz Aldrin likes coffee. Even burnt, hours-old office coffee is palatable to the 63-year-old former astronaut who pulls hard on his fifth cup of the morning. The hand clutching the cup sports a curious gold ring shaped like a crescent moon with a star facing it. "It's a little of the past and a little of the future," explains the second man on the moon. "It's what I'm all about."

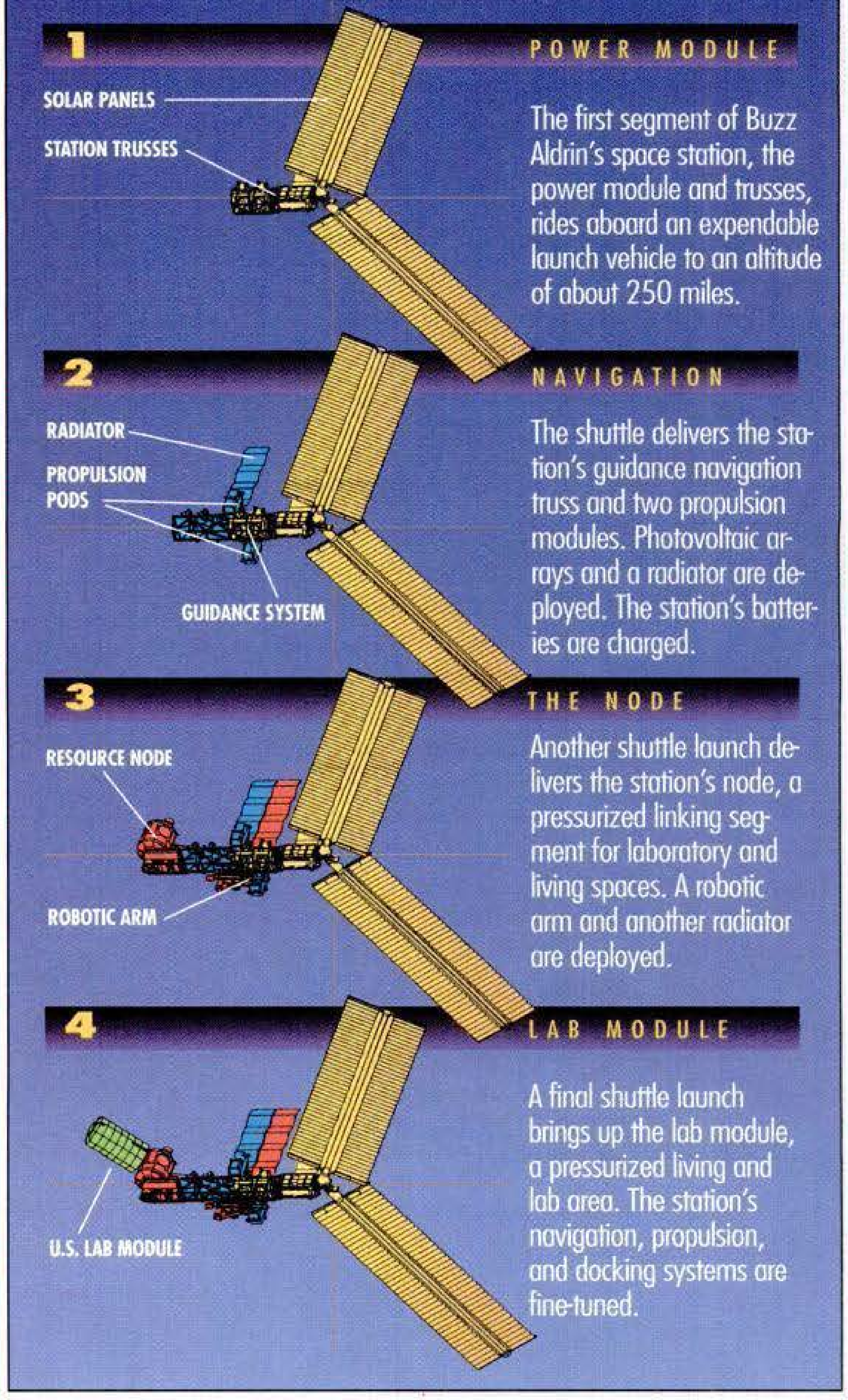
This complex, brilliant, stubborn man, still hale and steely 25 years after *Apollo 11* ferried him and Neil Armstrong to the moon's surface, has not rested on his laurels as some of his comrades have. Sure, he's proud of his role in the first moon landing, but that was long ago. Today, Aldrin has a new mission.

Aldrin wants to see an American space station in orbit and is doing everything within his wide-ranging sphere of influence to make it happen. Recent designs of the space station Freedom call for about 18 shuttle launches to transport the necessary materials into orbit. At close to $1 billion a launch, that strategy is no longer viable.

Not a test pilot but a West Point graduate with a doctorate in astronautics from the Massachusetts Institute of Technology in Cambridge, Aldrin has developed two alternatives that are receiving serious attention: One would use components already created for Freedom to put an operational station in orbit with just four launches (see illustration)—or with a single launch of Russia's huge Energia rocket. Essentially an abbreviated version of the original design, Aldrin's outpost would be one-third of the original station's size.

Aldrin foresaw the agreement between the United States and Russia for a joint space effort and designed the station to be "flown" to the Russian space station Mir for docking using hydrazine propulsion. The two stations can be joined and separated at will, with the Russian Soyuz TM capsule also serving the American station for emergency escape.

FOUR EASY PIECES



POWER MODULE

The first segment of Buzz Aldrin's space station, the power module and trusses, rides aboard an expendable launch vehicle to an altitude of about 250 miles.

NAVIGATION

The shuttle delivers the station's guidance navigation truss and two propulsion modules. Photovoltaic arrays and a radiator are deployed. The station's batteries are charged.

THE NODE

Another shuttle launch delivers the station's node, a pressurized linking segment for laboratory and living spaces. A robotic arm and another radiator are deployed.

LAB MODULE

A final shuttle launch brings up the lab module, a pressurized living and lab area. The station's navigation, propulsion, and docking systems are fine-tuned.

Should NASA scrap the current space station design, Aldrin has a second alternative: an original and patented design that could be up and flying in as few as two shuttle launches. His concept uses a modified shuttle external tank for living quarters, similar to the way Skylab used the remodeled second stage of a Saturn rocket. Surrounding the quarters is a cuboctahedral framework, which may be difficult to pronounce but would be easy to assemble in space. The shape resembles a pyramid with its top sliced off. Two of these shapes, with their broad bases at opposite ends, form a strong external skeleton. The design calls for Tinkertoy-like joints that allow for a wide range of options.

"I never thought I would become an expert at what the space station ought to be. It just gradually happened," says Aldrin. During the Gemini and Apollo missions, he played a key role in developing rendezvous techniques for spacecraft, a labor that earned him the nickname "Dr. Rendezvous" from his compatriots in the astronaut corps. It's a title that he still lives up to. "I'm trying to contribute to Mars orbit trajectories and come up with better strategies for getting us to Mars," he says in a mellow baritone voice. "There are many conditions that would lead a person to want to settle there and explore the surface."

In Aldrin's mind, space is still the frontier where American trailblazing spirit can find new expression. "It's selfish to say that we as a nation should be leaders. But we should strive to do the best. We grew up in this pioneering world in this country with an innate desire to extend our reach and our capabilities. It's in our blood."

MARIO FERRO

GLORY DAYS

Neil Armstrong may have earned the distinction of being the first man on the moon with a *prepared* speech, but Buzz Aldrin was just a few minutes behind him when he stepped onto the surface of the moon and uttered his completely *unrehearsed* response: "Magnificent desolation."

The way Aldrin tells the story, there wasn't much time to enjoy the moon. "It was a burden," he says of the distinction of being one of the first men on the moon. "It was like the little fifth grader who has to recite the Gettysburg Address in the school auditorium. The kid walks up there, and later he doesn't remember what happens. Hopefully, he can get the thing out. That's because of the pressure of being on stage. It sounds strange, but to me, we were on stage on the moon, and the whole world was listening, watching, observing, critiquing . . . to me, that's pressure."

Desolation remains Aldrin's chief impression of the moon's surface. "Where we went was intentionally selected to be the smoothest, most uneventful place you could possibly go to," he recalls. "As you stand there and look out, it's clear, and then it curves away about a mile distant. Now, that's not flat, that's not Kansas where the horizon disappears 20 miles away. There was no doubt that we were on a sphere. There would be no flat-moon society."—*S. F.*

AIR POLLUTION

THE FUTURE IS HAZY

More and more, visitors to U.S. national parks are complaining about what they see, or rather, what they don't see. Magnificent panoramas, breathtaking colors, and distant vistas are disappearing in a pall of haze. Thus there's inevitable disappointment for tourists traveling to such treasures as the Grand Canyon. Today, the average visual range in the western United States, including national parks and wilderness areas, is 60 to 100 miles, one-half to two-thirds the distance that would be crystal-clear in the absence of air pollution. In the parks of the East, the average visual range is only 20 miles, a mere one-fifth of the natural range.

Now a report by a National Research Council committee states that focusing solely on individual polluters in an effort to combat haze is "doomed to failure." "Most of the haze in wilderness areas comes from windblown pollution from many sources spread over hundreds of miles, not just from a few nearby smokestacks," explains committee chair Robert A. Duce of Texas A&M University in College Station.

The Clean Air Act amendments of 1977 set national goals for correcting haze problems in the national parks and wilderness areas, but the committee report says that progress has been "extremely slow." The reason: The current program lacks adequate resources and targets few of the major culprits, such as coal-burning power plants.

The report pessimistically concludes that visibility in the nation's parks will not improve if we rely only on the measures now in place. The committee recommends "a comprehensive national visibility improvement strategy."
—*Arthur Fisher*

MEDICINE

CHILLING A KILLER

Physicians at Allegheny General Hospital in Pittsburgh are eradicating prostate cancers by freezing them. In the experimental technique, surgeons use ultrasound imaging to insert probes through the skin and into the prostate gland. They then circulate supercooled liquid nitrogen through the probes to freeze the tissue, which is later absorbed by the body. Prostate cancer, the second leading cause of cancer deaths in men, affects one in nine American males.

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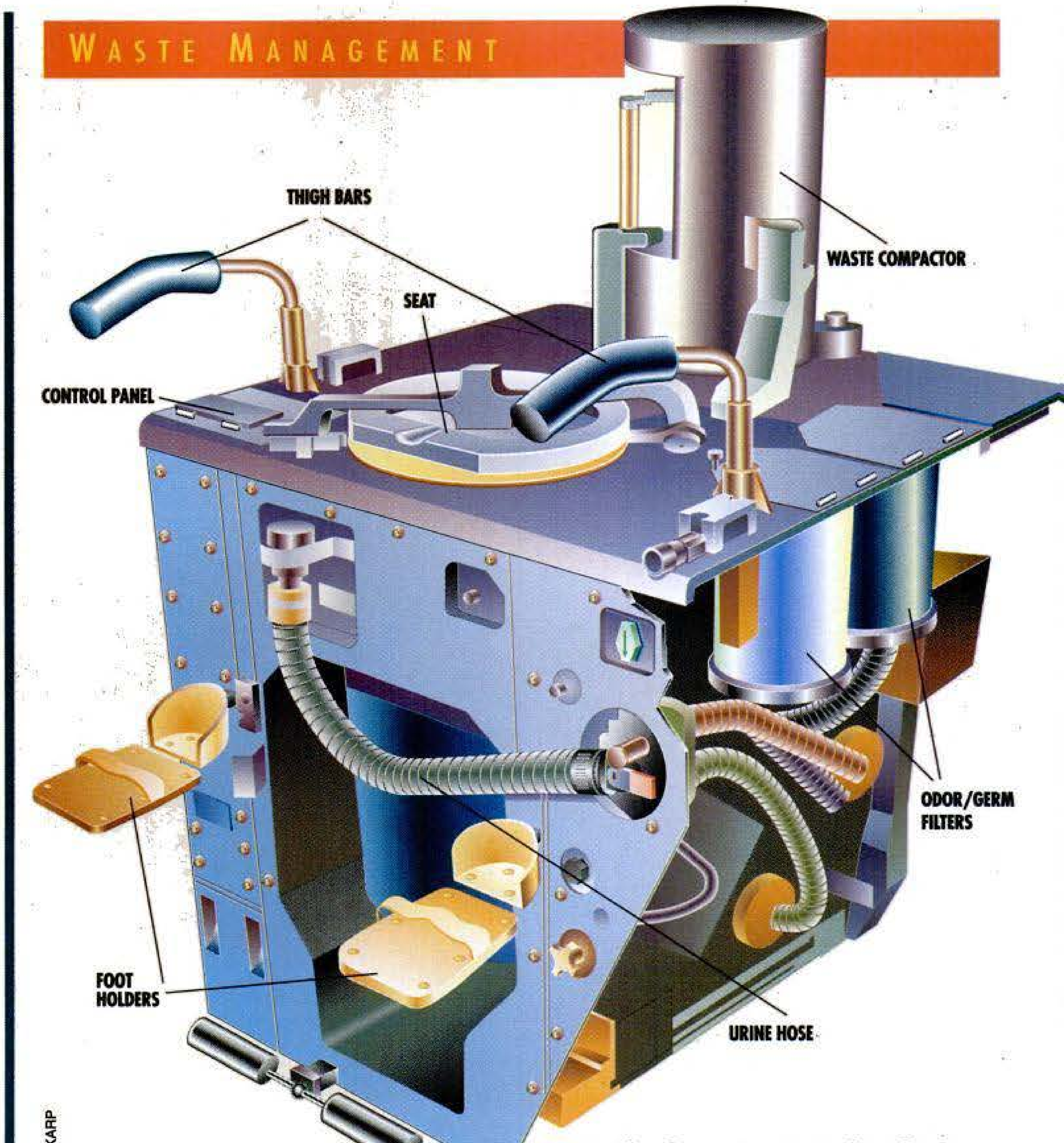
WASTE MANAGEMENT



STEVE KARP

A sucker for waste: On Earth, toilets use gravity; the space version relies on suction.

MONEY DOWN THE DRAIN

Answering nature's call has never been more expensive. A new toilet for the space shuttle *Endeavour* cost NASA $23.4 million—$20 million more than planned, the agency admitted to the House Space Subcommittee recently.

"This is not simply a toilet, but a complete sewage collection and treatment plant . . . contained in a space one-half the size of a telephone booth," NASA associate administrator Jeremiah Pearson III told the House panel. He conceded that the agency underestimated the complexity of the device, which has 4,000 parts, when it first awarded the engineering contract. (Unfortunately, a space bidet for the shuttle is not included.)

A congressional staffer calls the cost overrun typical of NASA mismanagement, noting that "the contract was set before the agency knew what it wanted." One proposed solution: Create an independent NASA unit that would review costs, and perhaps prevent NASA from getting caught with its pants down again.
—*Robert Langreth*

FOOD SCIENCES

HAUTE CUISINE

Blend minced mackerel, pickle relish, green onions, hard-boiled eggs, walnuts, cream cheese, and spices. Sound disgusting? Not to the muffin boffins at Cornell University's College of Agriculture and Life Sciences in Ithaca, N.Y. They have invented a microwaveable English muffin with the mackerel mix in a bagel-like hole at its center and shredded cheese on top. When microwaved in a special plastic container, the boffins say, the resulting melt-down is just yummy.

The road to the microwaveable MackMuffin was littered with such rejects as the fish taco-burger and the fish pizza-burger.

The aim of this culinary caprice is to find more outlets for mackerel, a fish with an excellent nutritional profile that is spurned by almost everyone except cats.—*A. F.*

AVIATION

DOUBLE-DUTY AIRCRAFT

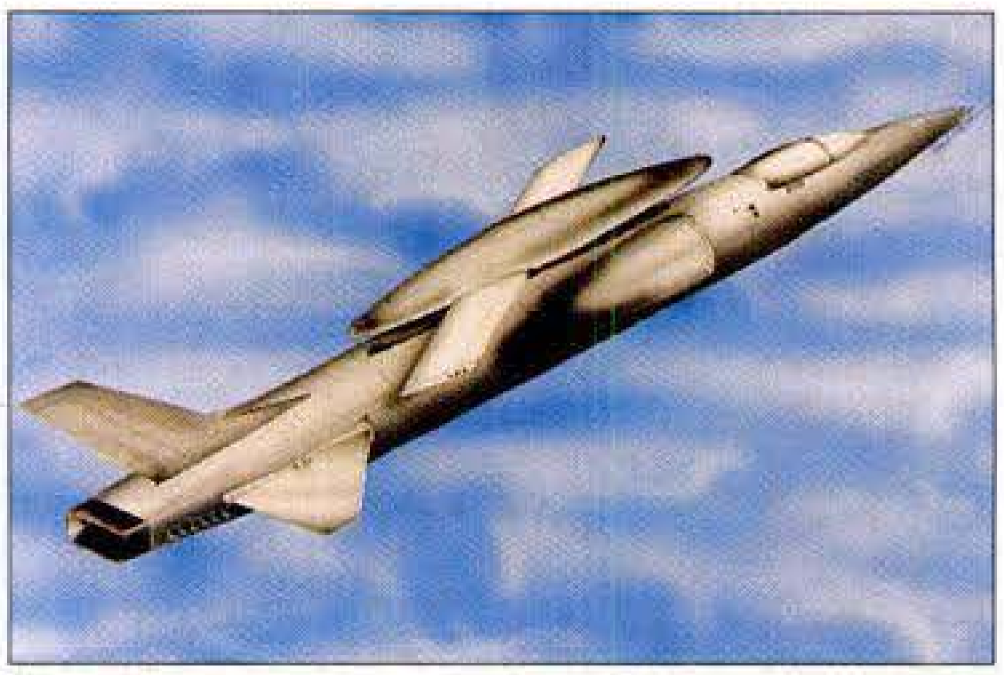
For years, aircraft designers have attempted to combine the best features of helicopters and planes. One of the latest concepts, developed at NASA's Ames Research Center at Moffett Field, Calif., is called the M-85 because it would not only take off and hover like a chopper, but would also cruise at speeds up to Mach 0.85.

Atop the M-85 is a large, circular fairing with two, three, or four rotor blades. The fairing and extended blades rotate like a helicopter rotor. Because the fairing is so large, it provides enough lift to support the aircraft while it is converting between rotary- and fixed-wing flight.

During conversion, the rotor blades retract into the hub, and the left blade flips over so that its leading edge faces forward. (During rotary-wing flight, the leading edges point in the direction of rotation.) The rotor then stops, and the blades are extended to serve as conventional wings. The blades can also remain extended while they are reoriented.

While the design could use two, three, or four blades for helicopter-style flight, only two would be used for fixed-wing flight. They could be extended in an oblique configuration, or swept rearward or forward, for high-speed flight.

Unlike a helicopter, which has a rotor that tilts downward for forward acceleration, the M-85 fairing has a positive angle of attack. Fan-jet engines attached to the fuselage provide thrust for forward flight. The concept could be used for aircraft ranging from high-performance fighters to commuter airliners.—*Bill Siuru*



A large fairing atop the M-85 provides lift while the aircraft converts from rotary-wing flight to the fixed-wing mode shown here.

MATERIALS

FIRST EVERLASTING ALLOY

There's a new alloy that apparently just won't give up. When a pin was scraped along it the equivalent of one million times, the alloy—made of zirconium, palladium, and ruthenium—displayed no net loss of surface material. When astonished researchers at the National Institute of Standards and Technology (NIST) persevered with a five-million-cycle wear test, they got the same result.

Richard M. Waterstrat of NIST's research center in Gaithersburg, Md., invented the new alloy. It has no known toxic reactions with human tissue and is strong enough to be used surgically for tooth, hip, and knee implants. It could also be used as an industrial coating for high-performance bearings and mechanical joints.

The usefulness of the material stems from an unusual property: Under stress normally high enough to induce a permanent shape change, the alloy undergoes internal structural changes that actually increase its ability to resist further deformation and fracture.
—*A. F.*

Sporting Firearms

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Sturm, Ruger & Company, Inc., 31 Lacey Place, Southport, Connecticut 06490
Instruction manuals for all Ruger firearms are available free upon request.

ROBOTICS

PLANE INSPECTOR

America's hard-pressed airlines are keeping their planes in service longer, and older planes are more likely to develop structural problems. To check for deterioration, teams of workers inspect the lines of rivets that fasten an airplane's skin to its frame. They use hand-held sensors to find cracks resulting from thousands of pressurization-depressurization cycles, but this method has its disadvantages. "Inspecting an aircraft can involve hundreds of thousands of rivets," says Melvin Siegel of Carnegie Mellon University in Pittsburgh. "It can be boring, and people may stop concentrating."

To counter this problem, the Federal Aviation Administration asked Carnegie Mellon to develop an automated inspection system. "A robot can do the dull, dirty, dangerous work and let humans interpret the data and make decisions," explains Siegel.

Enter ANDI (Automated Non-Destructive Inspector), a robot that walks along a plane's fuselage on its seven suction-cup feet. Using the same sensors employed by human inspectors, ANDI scans the skin for corrosion and cracks, and records the data in its onboard computer. The robot alerts an inspector to possible defects. Eventually, data gathered by robots will also be used to detect flaw patterns for specific aircraft models.

Future versions of ANDI will use video cameras to spot visible defects. The researchers may even be able to create robots that can crawl into fuel tanks or engines.—*Jonathan D. Beard*

ECOLOGY

A TROUBLED WORLD

Built to be a self-contained environment in which the air, water, and nutrients would be perpetually recycled, the Biosphere 2 project has captured the public's imagination ["Inside Biosphere 2," Nov. '90]. But the glass-enclosed world near Tucson, Ariz., isn't the paradise that some visitors imagine it to be.

Plagued by complaints that their experiment lacks scientific rigor, the eight "Biospherians" inhabiting the miniature world have faced even more serious problems in recent months. When oxygen levels mysteriously fell to 14.5 percent—the equivalent of air at an altitude of about 13,400 feet—project leaders had to pump oxygen into the glass domes to avoid a medical emergency. Then, in March, researchers "imported" six species of predatory insects to help control crop-destroying mites.

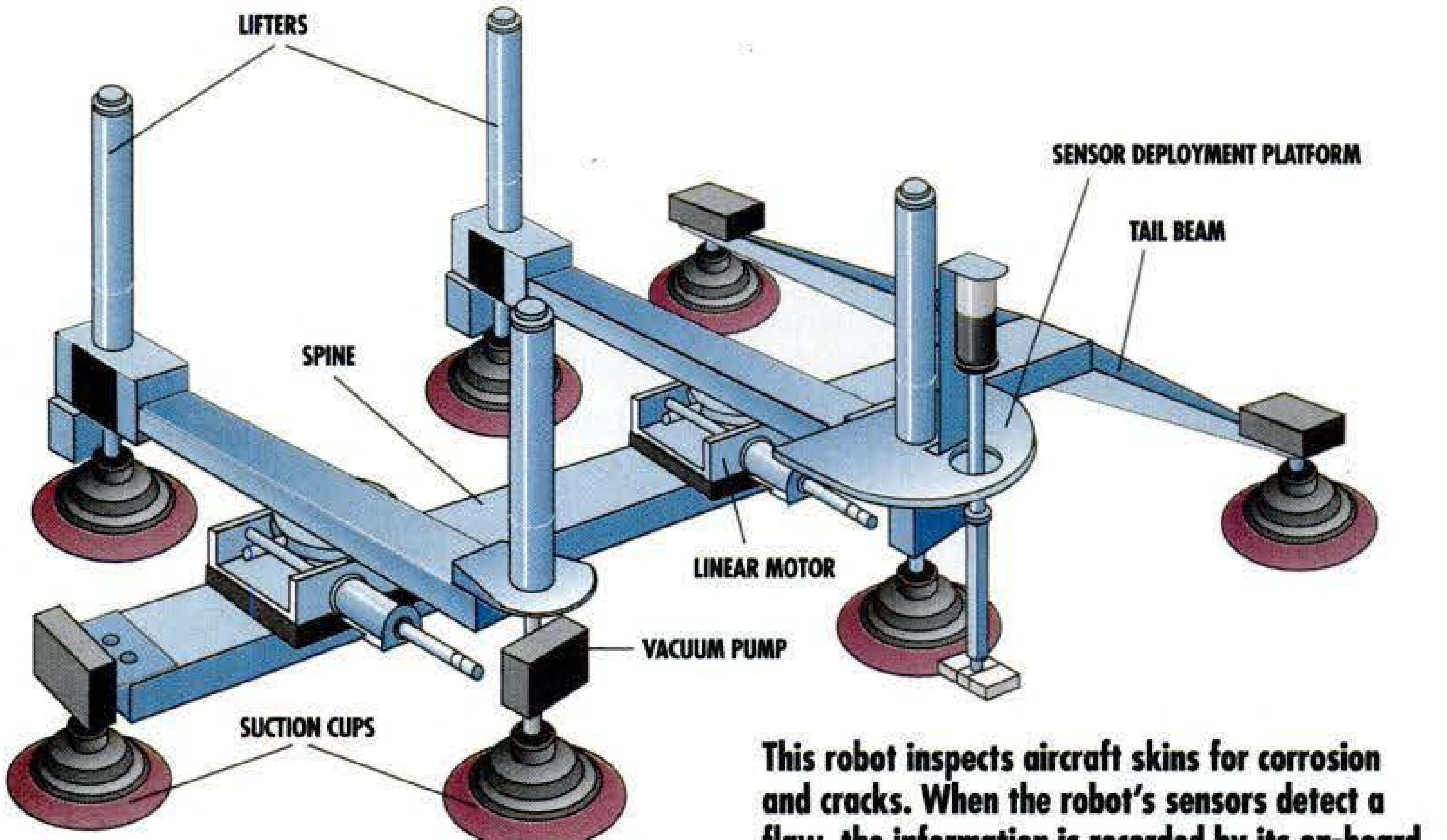
Although the Biospherians have grown most of their food, they have lost one-sixth of their body weight on average, and have had to dip into stored food supplies. When their two-year stint ends on Sept. 26, the Biospherians will swap places with a new crew that will continue the experiment.

WATER POLLUTION

WATER, WATER EVERYWHERE

Among the biggest water polluters, it turns out, is water itself: Contamination of lakes, estuaries, and rivers from pollutants in storm-water runoff may exceed that of industrial discharges in many cities. As the runoff water washes over buildings and pavement, it picks up trash, oil, animal feces, and other pollutants.

Studies have found elevated levels of metals and other poisons in urban runoff. Recently, the EPA acted on this knowledge, requiring cities with large builders, heavy industry, and more than 100,000 people to begin planning control of urban storm-water pollution. Later this year, similar rules will apply to light industry and small construction sites.—*Mariette DiChristina*



This robot inspects aircraft skins for corrosion and cracks. When the robot's sensors detect a flaw, the information is recorded by its on-board computer and forwarded to a human inspector.

KELLY YOUNG / CARNEGIE MELLON RESEARCH INSTITUTE

ENVIRONMENT

TOXIC TRAVELERS

The bottom of pristine arctic lakes in the north Hudson Bay area: That's where Mark Hermanson sets out to learn more about pollution.

"A lot of pollutants are dispersed widely by the atmosphere," explains Hermanson, an analytical chemist at The Academy of Natural Sciences in Philadelphia. Carried by wind, pollutants can travel thousands of miles before settling on a lake bed.

To track these contaminants, scientists push clear plastic tubes into lake-bottom muck to retrieve core samples. "Lake sediments store a nice long history because they accumulate rather slowly, maybe part of a centimeter every year," says Hermanson.

In previous years, researchers studying the Great Lakes have found substances such as the pesticide Toxaphene, used only on cotton crops in the South. "With no local sources, the only way they could have gotten there was through the atmosphere," says Hermanson.

To extend this work farther north, Hermanson recently dove to the bottom of the Imitavik and Annak lakes in Canada's Northwest Territories to collect sediment cores. Chemical analysis of the samples revealed elevated levels of lead, cadmium, copper, and zinc. The cores also showed a pollution increase during the post-World War II period of industrial growth and a drop in lead in recent years as environmental awareness has grown.—*M. D.*

In this sample, pollutants are mixed in the darker layer of sediment.

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Northwest Territory Screenhouse. 12′ x 12′. Front and rear vertical zippered doors. Includes carry bag.
47.88 **Everyday low price.**

Abu Garcia Ambassadeur Pro-Plus Baitcast Combos. Ultra-cast design. Stainless steel ball bearing. Graphite composite rod. Right-handed 5′9″ rod. Left-handed 5′6″ rod. Your choice.
SALE PRICE. 39.97

Mitchell Spinning Combos. P300M spinning reel with 6′ rod or P310M ultra-lite spinning reel with 5′ rod. Your choice.
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Coleman Camp Air Mat. Featuring I-Beam construction, double valves, rayon top, and vinyl bottom. Repair kit included.
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Normark Rapala Knife and Sharpener Combo. Fillet knife with stainless steel blade. Includes its own sharpener that may be used on other small blade knives.

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Folding Camp Stool. 16½″ high wood stool with 13″ x 10″ fabric seat.

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Zebco Spincast Combo. 404 spincast reel with 2-piece 5′9″ medium action straight handle rod.

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All **Zebco** Bullet Spincast Reels on sale. .38 Bullet with reduced friction line-release system and magnum gears. Or Model .22 Bullet reel. Your choice.

17⁶⁷ SALE PRICE.

Model 22TS. SALE PRICE. 19.97

Model .357. SALE PRICE. 25.77

Shimano AX Ultra-Lite Spinning Reel or AX QuickFire Spin Reels. Stainless steel ball bearing. No-Fail-Bail® Spring. Models AXULS, AX100Q, AX200Q, AX300Q. Your choice.

23⁹⁷ **Everyday low price.**

Model AX400S. 29.97 **Everyday low price.**

Plano Two-Drawer Tackle Box 707. Top lifts back, exposing 3 ½″ deep well for reels, line, knives, and other gear. Magnum Double Satchel 1119, 3-Tray 6803, or Double Action 1250. Your choice.

13⁴⁶ SALE PRICE.

Tackle shown in box not included.

Humminbird LCR Fish Finder. High-resolution LCD screen. Model LCR400ID.

99⁹⁷ SALE PRICE.

LCR400PR Portable. SALE PRICE. 134.97

All other Techsonic fish finders are also on sale.

Daiwa Apollo Longcast Spinning Combos. Model AG1305XB longcast spinning reel features ball bearing drive. Graphite constructed rod features bio-designed handle or Model AG500/18 ultra-lite spinning reel with 4 ½′ graphite rod. SALE PRICE. 29⁹⁷

Saltwater Combo. Model AG2600X/BW23. SALE PRICE. 44.97

Shakespeare® Ugly Stik® America's strongest, most sensitive rod. Blank-thru handle construction. Twist-lock reel seat. **Everyday low price.** 29⁹⁷

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Mountain Backpack. Front zippered pocket. Two zippered side pockets. Adjustable padded hip belt with quick-release buckle. SALE PRICE. 14⁹⁷

Northwest Territory Dining Canopy. 11′6″ x 11′6″ polyethylene canopy with steel poles, stakes, carry bag, and guy ropes. Fully-adjustable center pole. Model 80064 JWK. **Everyday low price.** 18⁷⁷

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17^{97} SALE PRICE.

Shakespeare Sigma Supra Combos. .035 reel with 6', 2-piece medium-action graphite composite rod. .040 reel with 7', 2-piece medium-/heavy-action graphite rod. .025 reel with 5', 2-piece ultra-lite action rod. Your choice. Reg. price 32.97.

27^{97} SALE PRICE.

Minn Kota 40T Trolling Motor. Four forward speeds, two reverse speeds. Turbo magnetic power and efficiency. Twist-grip one-hand control.

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Kent, Stearns, or **ERO.** Select adult or children's ski or life vests. Your choice.

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First Mate Boat Cover. Heavy-duty marine grade cotton canvas. Includes tie-down rope and bungee cord. Prices vary by size. SALE PRICE.

59^{97}-89^{97}

Jet Ski Covers also available.
SALE PRICE. 34.97-59.97

Wisconsin Pharmacal Baitmate Ultimate Baits. All natural scent, taste, feel, and action. Biodegradable. Choice of styles, sizes, and colors.
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Johnson Tube Catfish Bait. Assortment of flavors. Blood, chicken, liver, or fish. Your choice.
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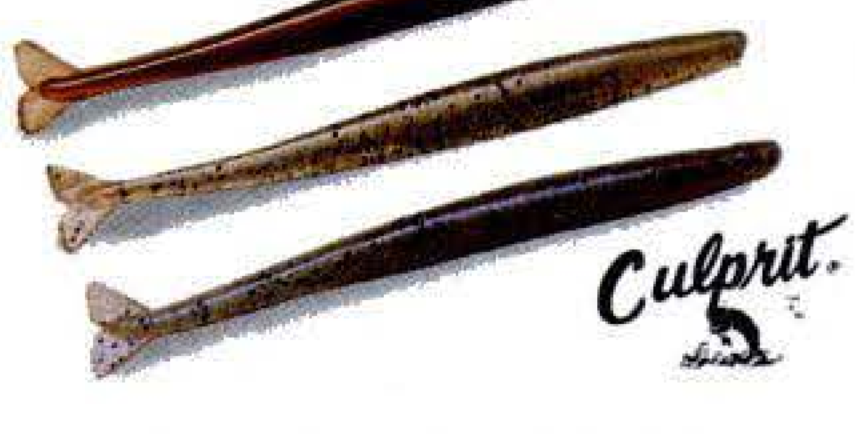
Magic Bait Catfish Bait. Prepared dough in assorted flavors. Non-refrigerated. 10 ounces.
SALE PRICE. 1^{99} Per pack

Culprit Jerk Worms. Choice of colors.
SALE PRICE. 2^{99} Per pack



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BOOK REVIEW

E.C. FOREVER

You don't know what E.C. means? Environmentally correct, of course. Now you too can be E.C. as well as P.C., with the aid of a new book by H. Steven Dashefsky called *Environmental Literacy—Everything You Need to Know About Saving Our Planet* (Random House; $12), a sampling from which appeared in our July 1992 special issue on the environment. The book is an encyclopedia of hundreds of environmental terms and names, arranged alphabetically and extensively cross-referenced. The "organic farming" entry, for example, refers you to "insecticides," "fertilizers," "crop rotation," and "monoculture."

In addition to the entries you might expect, Dashefsky has perked up his selection with such surprises as "Chief Seattle" (for his salute to the environment in an 1854 speech) and "Lois Gibbs" (the woman who blew the whistle on a toxic waste dump in Love Canal in New York.).—*A. F.*

AEROSPACE

SHUTTLE UPGRADE

The main engine of the U.S. space shuttle is safe to fly in future launches, but it could be rendered much safer and more reliable with a few key engineering modifications. That's the conclusion of a special task force of NASA's Aerospace Safety Advisory Panel (ASAP).

The ASAP report recommends five specific improvements to be made as a single package "as soon as possible." The changes include a large-throat main combustion chamber, a single-tube heat exchanger, an alternate high-pressure oxidizer turbopump, an alternate high-pressure fuel turbopump, and a two-duct power head. The task force found that just the addition of the new main combustion chamber would cut the probability of catastrophic engine failures from about once in every 120 missions to about once in 250 flights.

The shuttle's three main engines roar to life seconds before liftoff. They continue to burn during the eight-and-a-half-minute trip to orbit and return with the shuttle to be reused in subsequent missions.—*A. F.*

ASTRONOMY

NEW YORK TO LOS ANGELES IN FIVE SECONDS

It is the fastest star ever identified, and it is leaving quite a wake as it zooms across the galaxy. Astronomers have spotted a compacted neutron star traveling at around 2.2 million mph, or 600 miles per second. At that speed, it would cross North America in less than five seconds. By contrast, most stars meander at about ten miles per second.

Once larger than the sun, the star collapsed to a mere ten miles in diameter and is trailing a ten-trillion-mile-long wake of gas that it set aglow and that, oddly, has formed the pattern of a guitar. Scientists believe the pattern probably is the result of preexisting turbulence in the hydrogen gas in the region of the galaxy through which the star is passing.

Even though the star is 500,000 times denser than Earth, it is moving so fast that it will escape the gravitational hold of the Milky Way to traverse intergalactic space. The discovery suggests the vast expanse between galaxies could be littered with other swift-moving embers.

"It got a monstrous kick to a very large velocity," says Roger W. Romani, a Stanford University astrophysicist who observed the star. Astrophysicists believe the star gained its momentum from an asymmetrical supernova explosion one million years ago. When the original dying star imploded, the tremendous gravitational energy that was released may have been concentrated on one side, hurling the compacted star in the opposite direction.

Cataloged as PSR 2224+65, the star is 6,000 light-years from Earth in the constellation Cepheus. Its guitar-shaped wake is so dim that Romani, collaborating with two astrophysicists from Cornell University, needed the giant Hale Telescope at Palomar Observatory in Southern California to photograph it.—*David Graham*

ENGINEERING

ANTENNAS SHAPED BY STATIC CLING

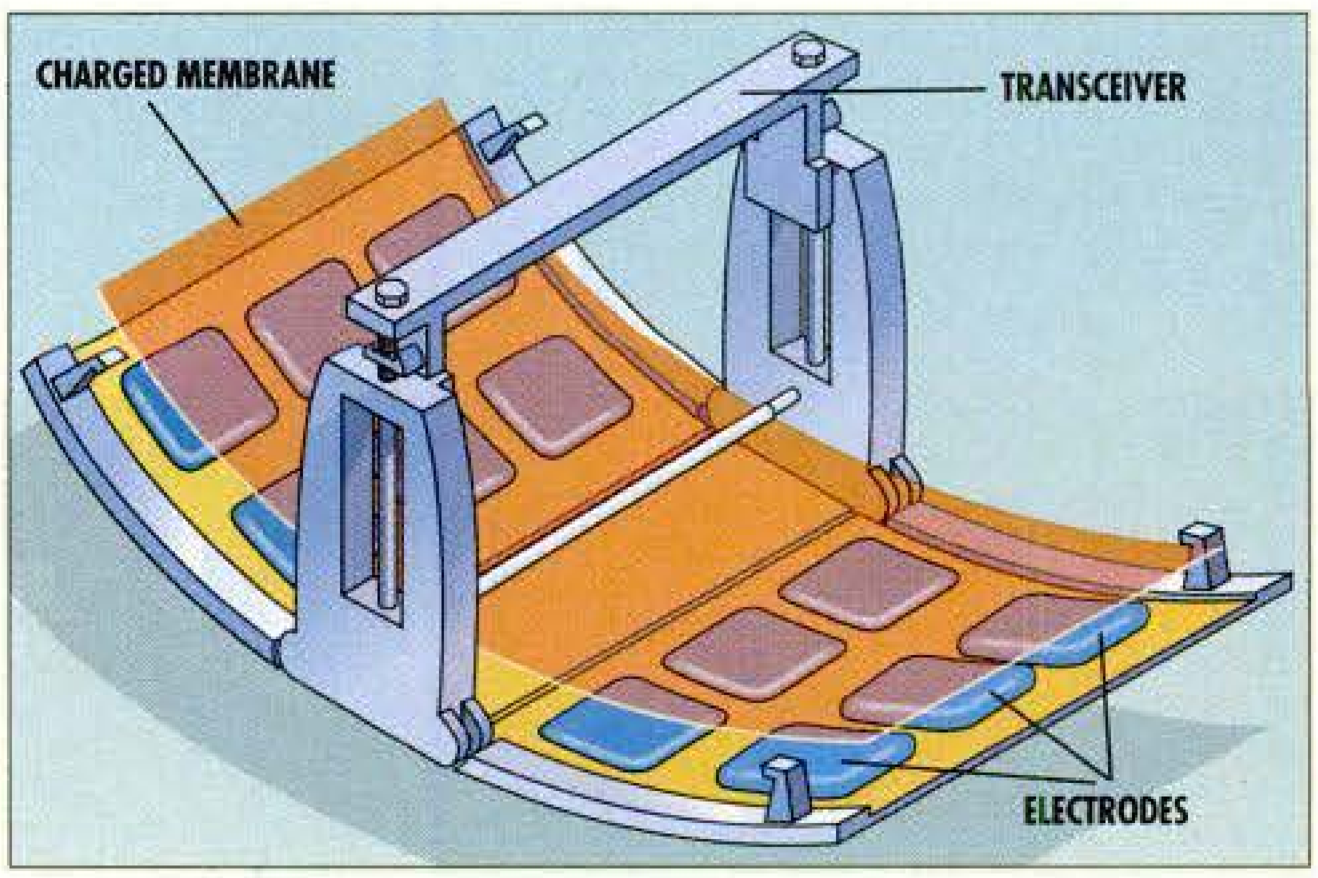
To most engineers, the idea of using static electricity for anything is shocking. Instead, a century of research has focused on ways to minimize the noisy nuisance. But North Carolina State University professor Larry Silverberg says static can be a friendly force, especially in space.

Silverberg recently proved that static charges can shape materials in predictable ways. He has applied for a patent on the concept of using static electricity to control large space-based reflectors. The concept's first application will be bigger eyes and ears for communications, weather, and intelligence satellites.

Researchers have long sought bigger space reflectors, but warping caused by constant heating and cooling makes dishes larger than a meter across useless. Today's typical satellite carries several meter-wide antennas that can't change direction unless the entire satellite is moved.

Prior attempts to control forces over large surfaces used a suspension-bridge strategy, with hundreds of pulleys and wires. That didn't fly. Silverberg's simple solution is static—a weak force, but mighty enough in space. His prototype bird will use battery-powered electrodes to precisely create an electric field around an aluminum-coated Mylar membrane. The resulting static charge over the flimsy film yields the evenly repulsive force that shapes the antenna.

"Not only can we maintain the shape, we can change it," Silverberg says. Each flexible antenna, replacing four or five smaller rigid ones, could save millions of dollars. The first system could be in orbit within five years. Silverberg predicts the new technology he calls "structural electrodynamics" will someday control giant sheets of solar panels that beam energy from space.—*Joyce Gramza*



STEVEN STANKIEWICZ

This flexible antenna can be attached to a satellite. Charged with static electricity by a battery, electrodes repel a thin aluminum membrane. Varying the amount of electricity changes the shape of the membrane.

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AUTOMOTIVE

EDITED BY DAN McCOSH

MOTORCYCLES

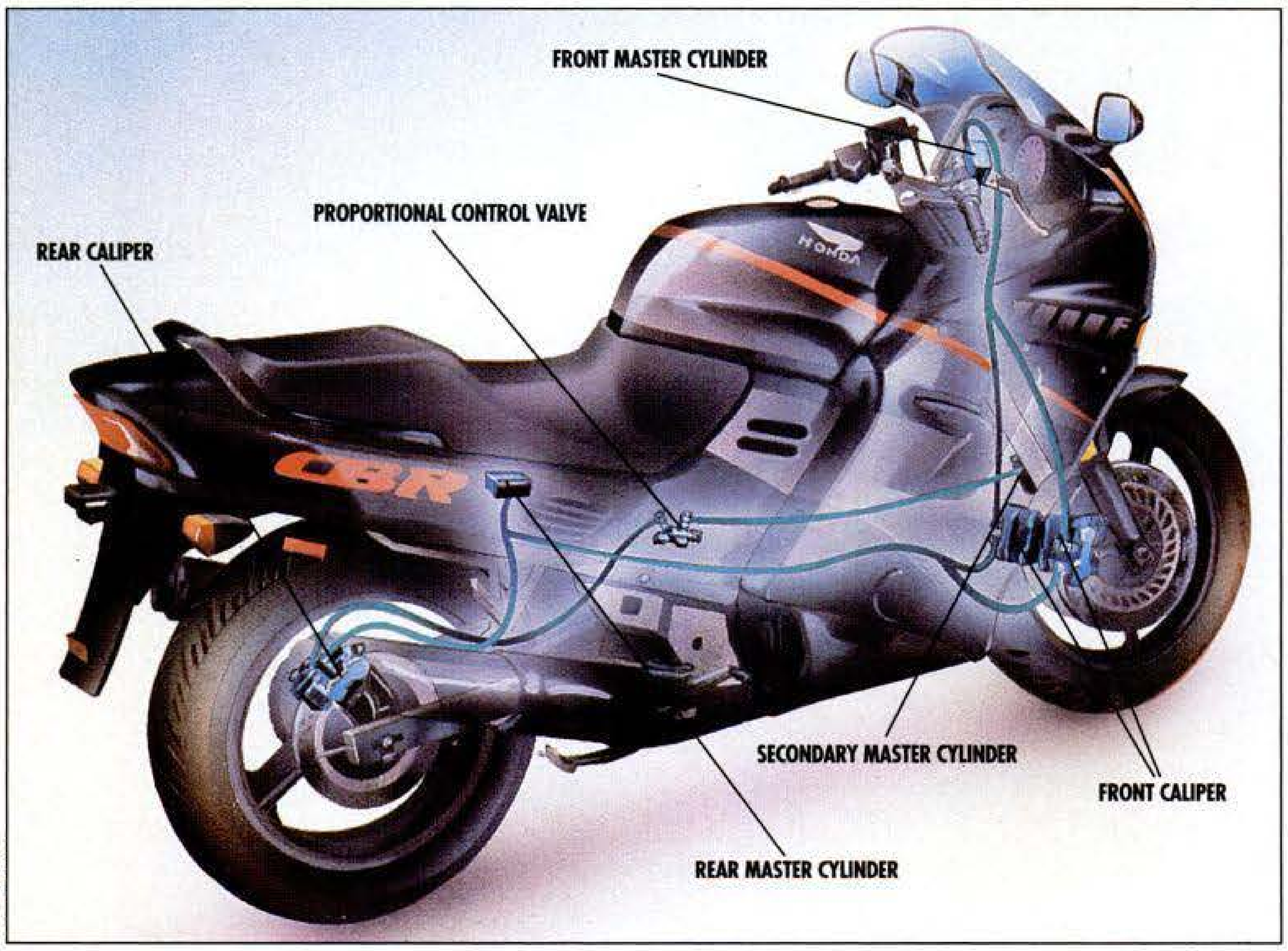
LINKED BRAKES FOR SAFETY

Slowing down a motorcycle quickly is a tricky business, requiring carefully developed skill and continual practice. Maximum braking power is generated by light pressure from the rider's right foot on the rear brake pedal, combined with a firmer squeeze on the right-hand lever controlling the front brake. It's like having a car with separate pedals for the front and rear brakes—something no driver would want.

Honda engineers have developed an innovative system that applies both the front and rear brakes when either brake control is used. The linked braking system incorporates a special proportional control valve that progressively varies the balance of the front and rear braking forces in three steps as the rider brakes harder, and the cycle's weight and tire grip shift toward its front wheel. Repeated stomping on the rear-brake pedal during a test ride failed to elicit the familiar squeal of rear tire rubber sliding on asphalt.

Previous designs used by Honda and Moto Guzzi of Italy have connected the rear disc brake to one of the two front discs via the foot pedal. But Honda's system goes further, applying brakes at the front and rear wheels all at once when only the hand lever is used—an important step toward reducing the chance of wheel lockup. A small, secondary master cylinder attached to the left-front brake caliper produces hydraulic pressure to operate the rear brake. When the lever is pulled, the left caliper pivots slightly and actuates the secondary cylinder through a mechanical linkage.

The system's hydraulic complexity requires three-piston calipers on all three brakes, with different pistons acting when the rider applies one or the other brake, or both at the same time. With no electronic components, however, the brake hardware is weightless and is much less expensive to produce than an antilock braking system. Where decent traction is available, linked braking will help most riders stop more quickly and safely. *—Stuart F. Brown*



Honda's CBR1000F is the first high-performance sport bike to have fully linked brakes. The front and rear brakes work simultaneously when the rider applies either the hand lever or foot pedal.

BOB LANGE

MATERIALS

LIGHTER WEIGHT COMPOSITES

In a first for the U.S. auto industry, a Big Three research consortium was awarded its first patent recently for a manufacturing process that simplifies and reduces the weight of structural composite components.

Instead of requiring foam cores for the molding of composite parts, the new technology, developed by the Automotive Composites Consortium, uses a blow-molded hollow core, reducing the weight of the part by 10 percent or more.

"The new process potentially will provide better fuel economy for future vehicles," says consortium chairman and Chrysler engineer John Fillion.

Currently, foam cores are wrapped with a fiber reinforcement, then they are placed in a mold. A liquid resin is injected into the mold, impregnating the fiber to form the composite part. A drawback to this process is that the foam core is sealed inside the component.

"With the new blow-molded core method," says Fillion, "the fabrication of complicated shapes in composites may be simplified with no loss to the durability or structural integrity of the component."

Fillion adds that it will take at least five years for such composite components to be used in a production car.

The Automotive Composites Consortium is one of 10 consortia grouped under the U.S. Council for Automotive Research (USCAR), which was formed in 1992 to manage the cooperative research programs now under way among Chrysler, Ford, General Motors, and various government agencies. The cooperative research projects include batteries for electric vehicles, exhaust emissions, recycling, and safety.*—Richard Stepler*

MANUFACTURING

BENDING METAL WITH WATER

Ever since the blacksmith's anvil gave way to the powered stamping press, there have been relatively few improvements in the methods of shaping steel. But a new technique promises to make it easier to manufacture the complex shapes used to construct frames and other heavy steel automotive components.

Dubbed hydroforming, the basic principle is akin to blowing up a balloon inside a closed mold. In this process, however, the balloon is hollow steel tubing expanded by hydraulic pressure. The patented process, developed by TI Vari-Form of Strathroy, Ont., can be used to fabricate hollow sections formerly assembled from several separate stamped pieces that are then welded together.

A few parts, including dashboard supports, are already in production, while frame assemblies are also future candidates for the new process.

CONCEPT CARS

DIMINUTIVE BMW

The idea of a more-or-less one-passenger "city" car acknowledges that most commuting is done by a solitary driver. The design has inspired numerous concept cars and even a few production cars. So far, though, none has been successful in the United States, where comfort and safety concerns have diminished their appeal.

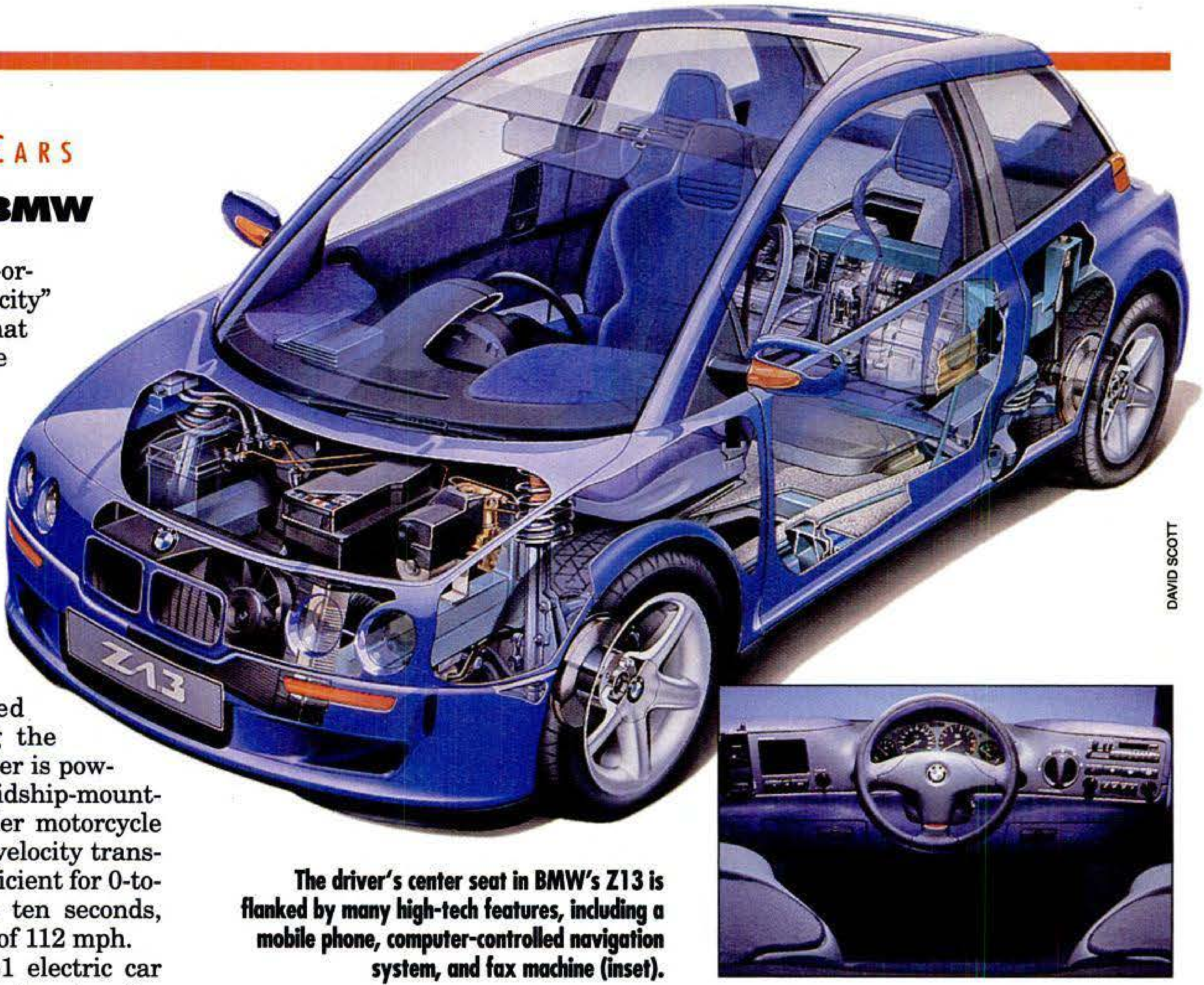
That hasn't deterred BMW from developing the Z13. The tiny three-seater is powered by a transverse, midship-mounted, 1,100-cc, four-cylinder motorcycle engine with a constant-velocity transmission and 85 hp—sufficient for 0-to-60-mph acceleration in ten seconds, with a maximum speed of 112 mph.

Reminiscent of the Z1 electric car series that BMW has displayed on the auto show circuit for the past two years, the project adds to the recurrent rumors that the automaker is considering a new line of small commuter-type cars in the next few years. Mercedes-Benz is reportedly considering a similar move—a reversal of the trend toward ever larger and more powerful German luxury cars.

The Z13 incorporates significant new technology, most notably an extruded aluminum frame, which will be introduced on the new Audi 100 Quattro this fall. Aluminum has been getting more attention recently because of its light weight and because it can be easily recycled from salvaged cars. A new extrusion process that makes shapes suitable for structural sections has been demonstrated recently on several concept cars.

The aluminum frame and body cut the weight of the car to 1,830 pounds, which allows fuel economy in the 47-to-56-mpg range. The front and rear body sections are soft plastic to prevent parking lot dings.

An unusual seating design yields maximum space: The center seat for the driver is flanked by two passenger seats set slightly behind it. This allows substantial passenger legroom and improves side-impact protection by adding crush space for the driver; passengers are protected by the rear cabin structure.—*Wordservice International and David Scott*

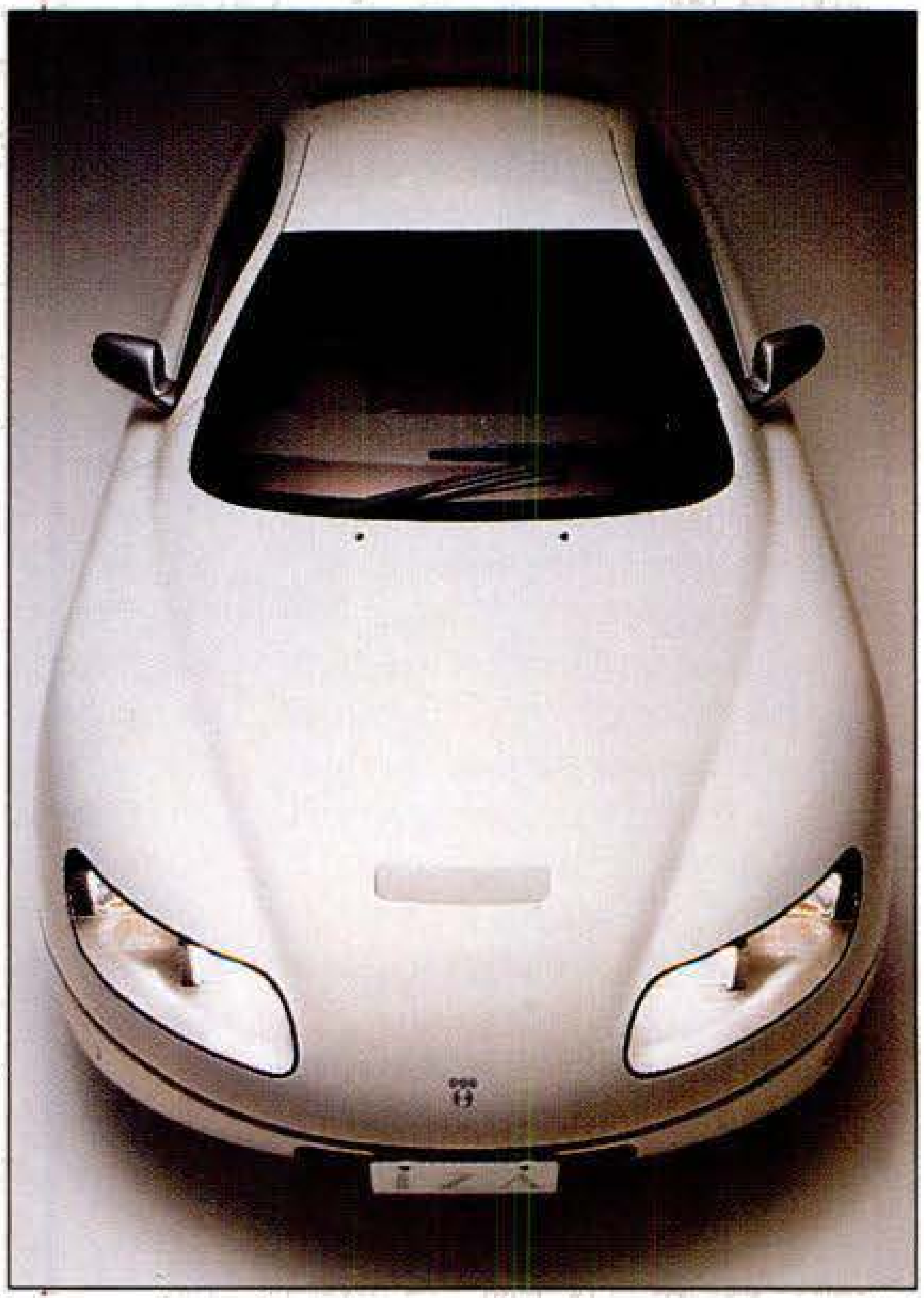


DAVID SCOTT

The driver's center seat in BMW's Z13 is flanked by many high-tech features, including a mobile phone, computer-controlled navigation system, and fax machine (inset).

PREVIEW DRIVE

PRICEY IZA PROTOTYPE



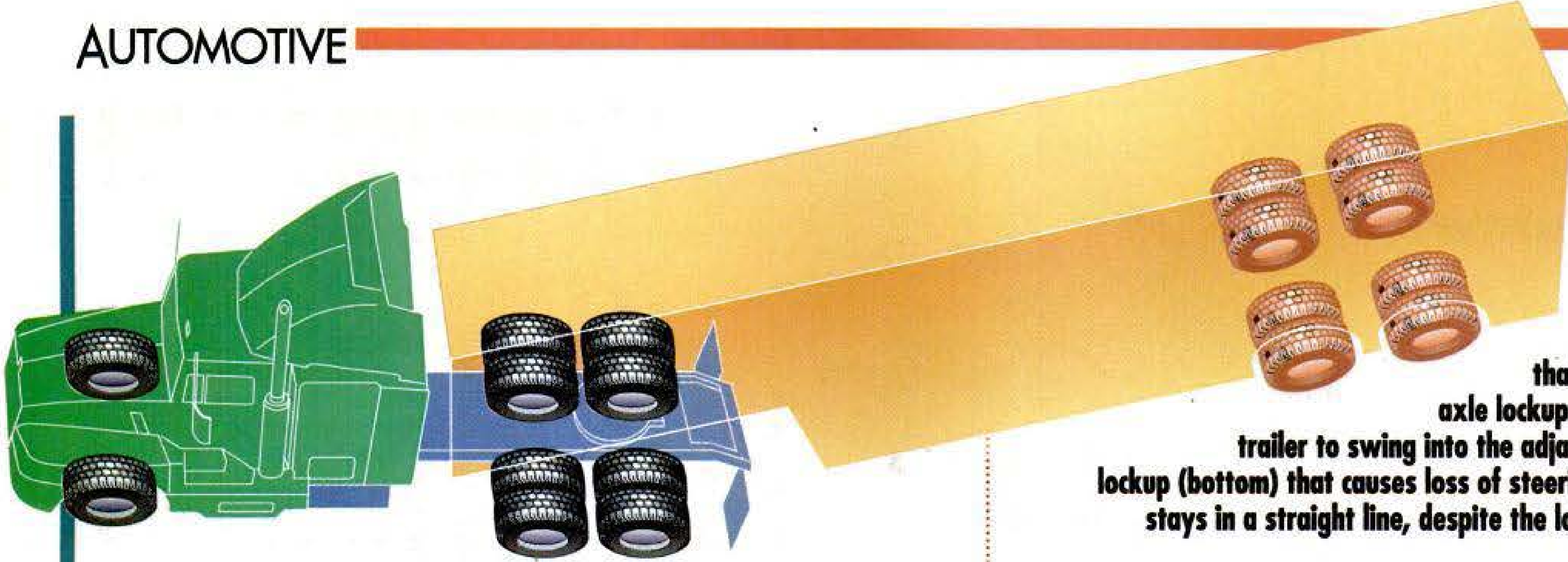
Tokyo R&D takes an unusual approach to electric cars: It mounts a brushless direct-current motor within each wheel. Remove the transmission and drive train, factor in a carbon-fiber-reinforced plastic body, and the Japanese automaker's IZA electric prototype weighs in at only 3,460 pounds, even with its 24 nickel-cadmium batteries.

Tokyo R&D's first prototype, the NAV, appeared in 1991 ["Electric Vehicles Only," May '91]. With support from Tokyo Electric Power, Tokyo R&D worked on its concept and produced the IZA, improving the top speed to 109 mph and extending the range between charges to 340 miles.

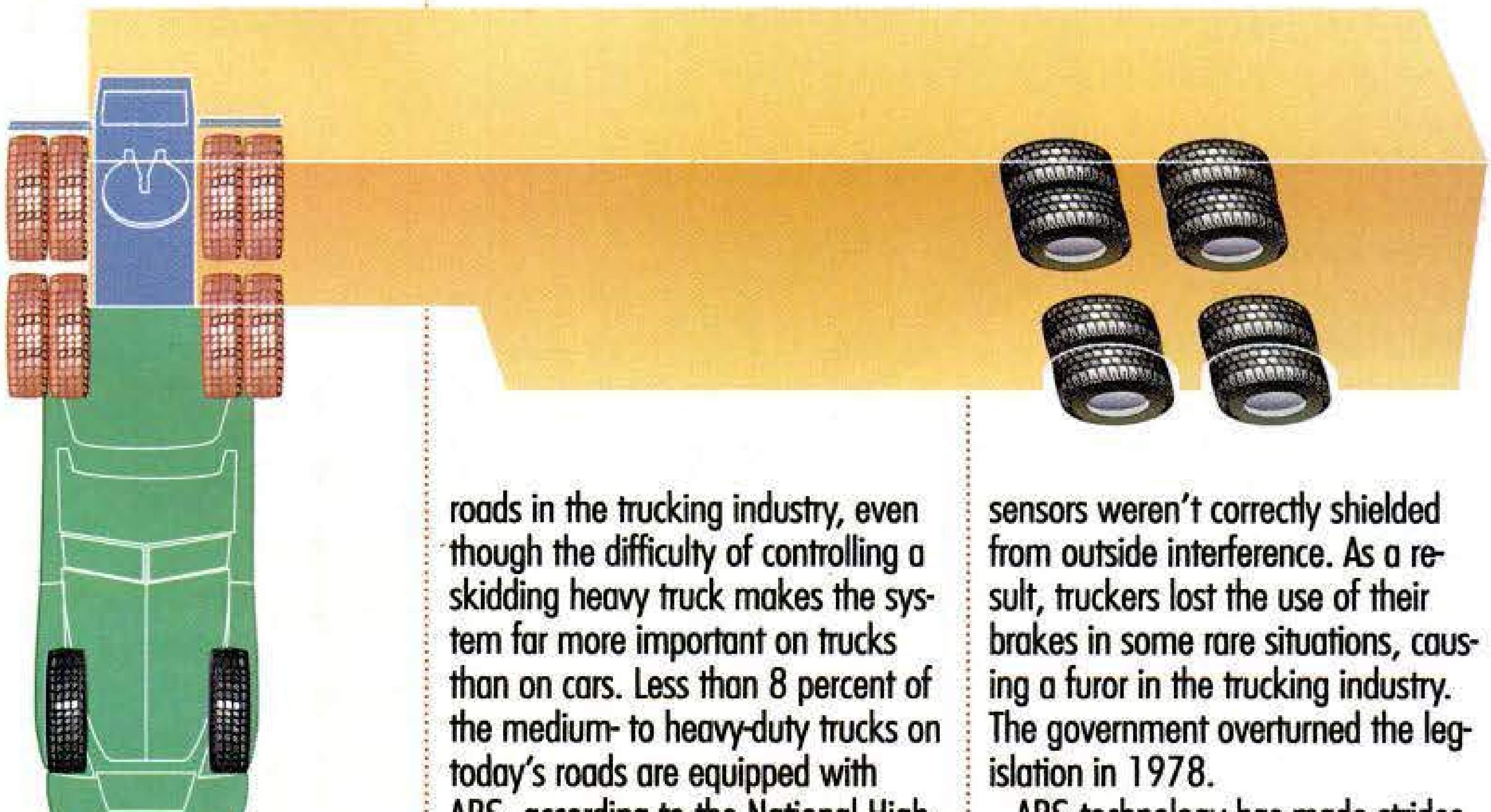
A recent test run in the suburbs of Yokohama didn't offer the chance to test those limits. In heavy expressway traffic though, the car ably kept pace, showing plenty of acceleration when merging into moving traffic and passing. The IZA handled lane-change maneuvers as smooth as any production car.

The ride struck me as a little harsh, however. A Tokyo R&D engineer attributed it to the double wishbone suspension—the type used on racing cars. (Racing cars are one of Tokyo R&D's specialities.)

The major problem with the IZA is its cost. Tokyo R&D won't even try to estimate the price of a production version, but with four motors and a carbon-fiber body, it's likely to be high. The company says it will try to produce its next version more economically. It also hopes one of the major carmakers will then pick up the idea and commercialize it.—*Dennis Normile*



Antilock systems correct three kinds of brake problems on big rigs: drive axle lockup (below, in red) that induces jacknifing, rear axle lockup (left) that can cause the trailer to swing into the adjacent lane; and front axle lockup (bottom) that causes loss of steering control, but the truck stays in a straight line, despite the loss of directional control.



ANTILOCK BRAKES

MAKING A COMEBACK IN THE BIG RIGS

BY CHUCK MURRAY

When test driver Mike Godfrey demonstrates antilock brakes, he literally stands in the cab of his truck and jumps on the brake pedal. You would hate to look in your rearview mirror and see another driver using Godfrey's technique, and it's not recommended for anyone traversing a slippery roadway. His intention is merely to simulate a worst-case stopping scenario for a truck driver.

In tests with standard brakes, Godfrey skidded, furiously steering in the direction of the turn, but was unable to maintain control. With a new antilock brake system developed for medium-duty trucks, however, Godfrey stood on the brakes repeatedly while driving on a track covered with four inches of fresh snow. The result? The truck stopped every time without loss of steering control.

Outside the vehicle, observers heard the staccato popping and hissing of the antilock air brakes, which automatically pumped at a rate of five times per second. The pumping occurs when a control unit activates a pressure-modulation valve, which instructs a solenoid at the brake chamber to release pressure. The wheel then regains velocity, preventing the truck from skidding.

Chicago-based Navistar International, which incorporated ABS on the International 4900 Class 6 truck used in the test, was the first truck manufacturer to introduce ABS to medium-duty trucks in 1992. The company, which employs ABS designed by Allied Signal Automotive's Bendix Heavy Vehicle Systems Group, is one of several truck manufacturers now offering ABS as an option on selected trucks.

ABS has been slow to make inroads in the trucking industry, even though the difficulty of controlling a skidding heavy truck makes the system far more important on trucks than on cars. Less than 8 percent of the medium- to heavy-duty trucks on today's roads are equipped with ABS, according to the National Highway Traffic and Safety Administration (NHTSA). In contrast, more than 30 percent of cars and 80 percent of light trucks and vans have ABS. Researchers say the situation is particularly unfortunate with tractor trailers, which are prone to jackknifing when the brakes lock.

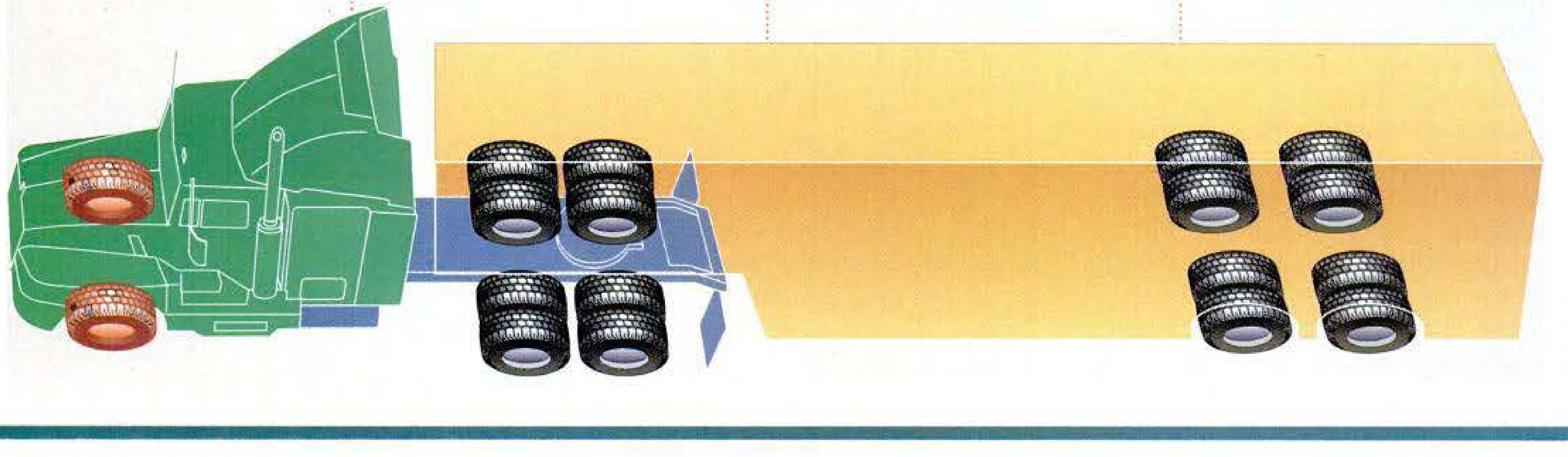
"Locked wheels don't generate lateral traction," says Robert Clarke, chief of the Heavy Vehicle Research Division for NHTSA. So a tractor trailer without ABS is more likely to jackknife than one with ABS.

Truckers, however, have a powerful reason to be suspicious of antilock brakes. Many remember the debacle of FMVSS 121—a federal safety standard from the mid-1970s that compelled them to equip their rigs with antilock systems. The standard was a disaster because the early ABS computers and magnetic sensors weren't correctly shielded from outside interference. As a result, truckers lost the use of their brakes in some rare situations, causing a furor in the trucking industry. The government overturned the legislation in 1978.

ABS technology has made strides since then, as indicated by its acceptance in passenger cars. A recent Department of Transportation-sponsored study followed 200 tractor trailers from each of seven major manufacturers across 40 million miles of driving. In the study, the drivers felt that 34 accidents were avoided because of ABS. The incidence of problems with ABS? Zero.

Such findings may be helping ABS make a comeback in trucks. NHTSA is expected to mandate the gradual adoption of ABS next year for heavy trucks—first on tractors, then on trailers, then on single-unit trucks, and finally on buses.

This time experts are predicting that truckers will forget the failures of the analog ABSs of the 1970s. Notes Clarke: "Universally, drivers change their opinions after they have tried these new systems." PS



STEVE KARP

NOISE REDUCTION

QUIET BUSES

A Montreal bus company will be evaluating a new system of active noise cancellation that promises to reduce dramatically the exhaust noise of its heavy-duty diesels.

Noise Cancellation Technologies, based in Stamford, Conn., developed the system, which uses digital-signal-processing technology for high-speed analysis of selected, undesirable noises in a chosen environment. Based on that analysis, the system produces an equal but opposite sound wave—so-called anti-noise, which reduces noise and vibration.

New York and other cities are also testing the electronic muffler system.

PETER HOEY

BATTERIES

CORROSION KILLER

Corrosion of battery plates, especially under the deep discharge required by electric vehicles, is what limits the life span of lead-acid batteries. Toyota and Japan Storage Battery claim that granules of hydrous silicon dioxide packed between the battery plates inhibit this corrosion.

In laboratory tests, sealed lead-acid batteries with the silica packing have tripled the life cycle of conventionally sealed lead-acid batteries. An unsolved problem is that the silica absorbs hydrogen from the electrolyte, which gradually diminishes.

To get further performance data, Toyota plans to use the new batteries in a luxury electric car based on its Crown Majesta. Toyota is making a limited number of the cars available for use by government agencies in Japan.—*D. N.*

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When you dump the used motor oil from a single oil change in the trash, pour it on the ground, or toss it into the sewer, it seeps down into the water table and ruins 1,000,000 gallons of fresh water. In fact every year "do-it-yourselfers" improperly dispose of 220,000,000 gallons of used motor oil. That's why Valvoline Environmental Services is so important. Now you can take all of your used motor oil down to a participating retailer, where they'll collect it for free. Then Valvoline arranges to pick it up and recycle it. So look for the Valvoline Environmental Services logo at fine retailers everywhere and recycle your used motor oil. Because if you're not a part of the solution, you're a part of the problem.

1 GALLON OF USED MOTOR OIL CAN RUIN 1 MILLION GALLONS OF FRESH WATER

Valvoline ENVIRONMENTAL SERVICES

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ELECTRIC CARS

ALL FOR ONE?

In the wake of General Motors' decision to delay indefinitely production plans for its Impact electric two-seater ["Automotive Newsfront," April], the U.S. Council for Automotive Research (USCAR) has announced that the Big Three automakers have signed an agreement to explore the possibility of designing, testing, and building electric vehicles jointly, a first for the U.S. auto industry.

USCAR, based in Dearborn, Mich., manages cooperative research projects among GM, Ford, Chrysler, and federal government agencies. "One alternative," says Arvin Mueller, one of three members of USCAR's governing council and general manager of the GM Tech Center, "is that if the three car companies sell the same electric car, it could be sold as an 'USCAR' brand."

In any event, if GM, Ford, and Chrysler are to meet California's 1998 deadline for 2 percent of the cars sold there to be zero-emissions vehicles, then the automakers must decide by the end of 1993 whether the electric car will be a joint venture or whether each company will sell its own version.

Meanwhile, GM plans to build 50 Impact prototypes for use in test fleets; Ford will put sodium-sulfur-battery Ecostar delivery vans in test fleets; and Chrysler will offer its TEVan, an electric version of its minivan, in limited numbers.

The battery remains the missing link for a competitive electric vehicle, Mueller admits, adding that "we're still at the advanced golf cart level—some even call it a flashlight." —*R. S.* PS

TIRES

ROCK-CLIMBING WITH WHEELS

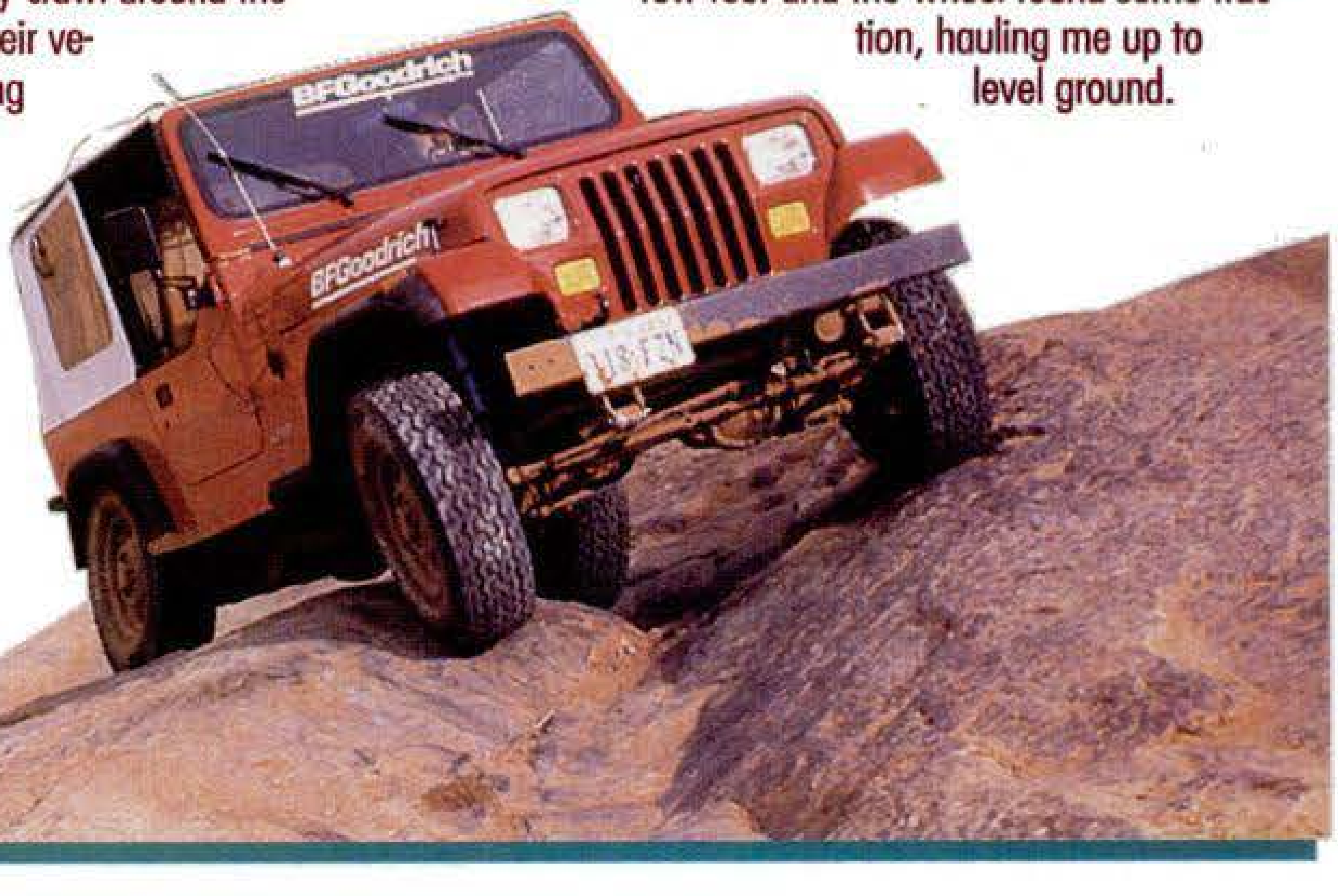
Hanging on the edge of a cliff with nothing visible through the windshield but clouds and sky, I glance in the rearview mirror and see a rocky ledge a couple of hundred feet below, where our rock-climbing instructor is waving his arms. Exactly why he is waving is not clear. Meanwhile, the right-front wheel of the Jeep Wrangler I'm driving is spinning in the air and the rear wheels are straddling a crevasse wide enough to lie down in. If the machine can't be coaxed forward a few more feet to level ground, the only alternative is to go backward, maybe sideways, down to the safety of the ledge below.

The chance to see exactly what kinds of rocks, crevasses, holes, and boulders a four-wheel-drive vehicle can climb over draws several thousand enthusiasts to Moab, Utah, every spring. There, they crawl around the rocky terrain in their vehicles at something slower than a walking speed.

The secret, participants quickly learn, is traction—applied as slowly as possible. This often allows crawling up slopes that can't be climbed on hands and knees. You can also descend hair-raising slopes, relying on engine braking, four-wheel drive, and calm nerves.

Highly specialized tires are essential. Climbing requires a soft compound that compresses into the tiniest crack on the rock face and has plenty of grip. The relatively small number of climbing devotees might limit any tire company's enthusiasm to produce such an unusual tire, but nevertheless, BF Goodrich is introducing new Moab editions of its familiar All-Terrain T/A radials and Mud-Terrain T/A off-road tires that have a special compound suited to the Moab climb. The company uses three flexible polymers in the compound to increase the mechanical grip.

Goodrich claims the tires stick to the rocks about 15 percent better than standard all-terrain tires, with some penalty in on-highway durability. The new Moab compound also enhances ice and snow traction. Whether or not the tire deserves credit for lifting me past the edge of the cliff is unclear: With a little body English on my part, the front end of the Jeep slid over a few feet and the wheel found some traction, hauling me up to level ground.



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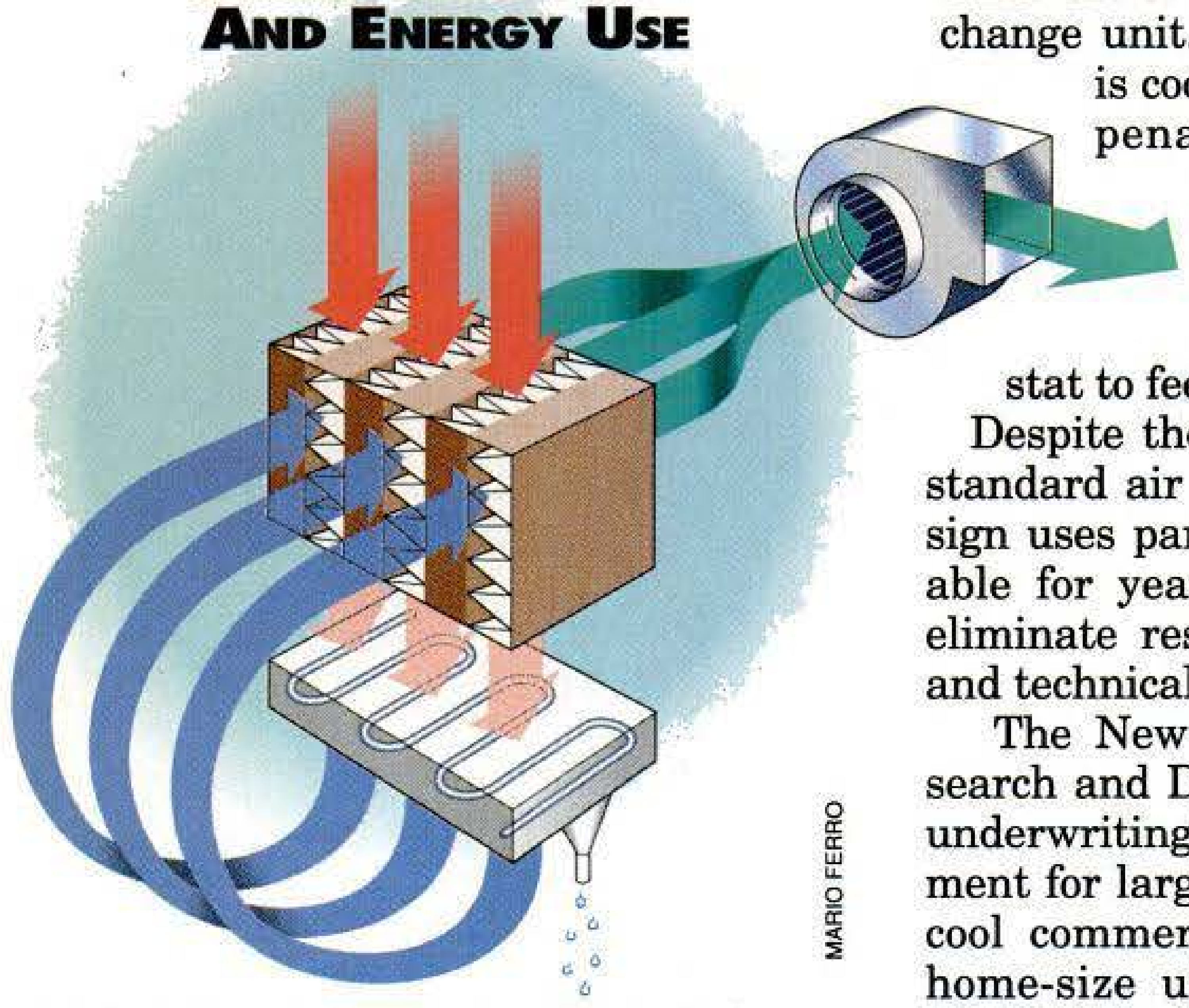
HOME TECHNOLOGY

EDITED BY SANDY FRITZ

AIR-CONDITIONING

LOWER HUMIDITY— AND ENERGY USE



A plate-type air-to-air heat exchanger is the crux of this innovative air-conditioning design.

MARIO FERRO

Why does 80 degrees in Phoenix, Ariz., feel so different from 80 degrees in New York City? Humidity. Remove it, and even hot air seems more agreeable. Now, an elegant air conditioner designed by Walter Stark, president of Nautica in Halesite, N.Y., cools air far more effectively than traditional air-conditioning units while it dehumidifies, using about half the energy of conventional systems.

Stark's patented design, developed with a grant from the Department of Energy, employs a plate-type air-to-air heat exchanger that both cools and dehumidifies the air before it reaches the cooling coil. Warm, damp air from the room is pulled through the heat exchanger, making it slightly drier and cooler before it reaches the cooling coil. Once through the coil, which condenses much of the humidity from the air, the stream is rerouted through another set of channels in the heat-exchange unit. The result, says Stark, is cool, dry air with no energy penalty. Drier air is more comfortable, so users of Stark's system probably will not need to crank down the thermostat to feel cool.

Despite the radical departure from standard air conditioners, Stark's design uses parts that have been available for years, a move that should eliminate resistance from repairmen and technical designers.

The New York State Energy Research and Development Authority is underwriting the next step in development for large-scale units intended to cool commercial buildings. Smaller, home-size units could be available within three years.

WOOD VS. PLASTIC

CUTTING BOARDS: MORE CONTROVERSY

With so much of what we eat, drink, and breathe being labeled toxic, few people were surprised when the winter 1991 issue of the U.S. Department of Agriculture's *Food News for Consumers* announced that wooden cutting boards are a health hazard.

But at least two people, Dean Cliver and Nese Ak, microbiologists at the University of Wisconsin's Food Research Institute in Madison, questioned the announcement. "I tried to track down where this advice came from," recalls Cliver. "But nobody knew." Accordingly, the team conducted their own experiments. Their findings: A clean wooden cutting board actually resists intrusions from dangerous bacteria. Plastic cutting boards, recommended as a safe alternative, scratch more easily, giving microbes a far better foothold for breeding.

Why wood seems to neutralize toxic microorganisms is unclear, but Cliver plans to "follow the little critters into the wood pores" to find out.—*Patricia Barnes-Svarney*

MATERIALS

COUNTERTOPS GET TOUGH

Rolling down the incline and striking the countertop with a resounding *wham*, the 300-pound metal test "rhino" dramatically drove home a point for visitors at the recent National Home Builders show in Las Vegas: Nuvel, a new counter surfacing material, is tough. At $50 per linear foot installed, it's also half the price of solid surfacing, says Nuvel manufacturer Formica of Wayne, N.J.

Made of an engineered thermoplastic originally developed by GE for automotive bumpers, Nuvel looks like solid surfacing. But the 0.09-inch-thick, 31-inch-wide sheets resist stains, cracks, and burns better than conventional materials, and most marks can be removed with sandpaper. The sheets, which come in several colors, are laminated to traditional substrates such as plywood, particle board, or medium-density fiberboard. *—Mariette DiChristina*

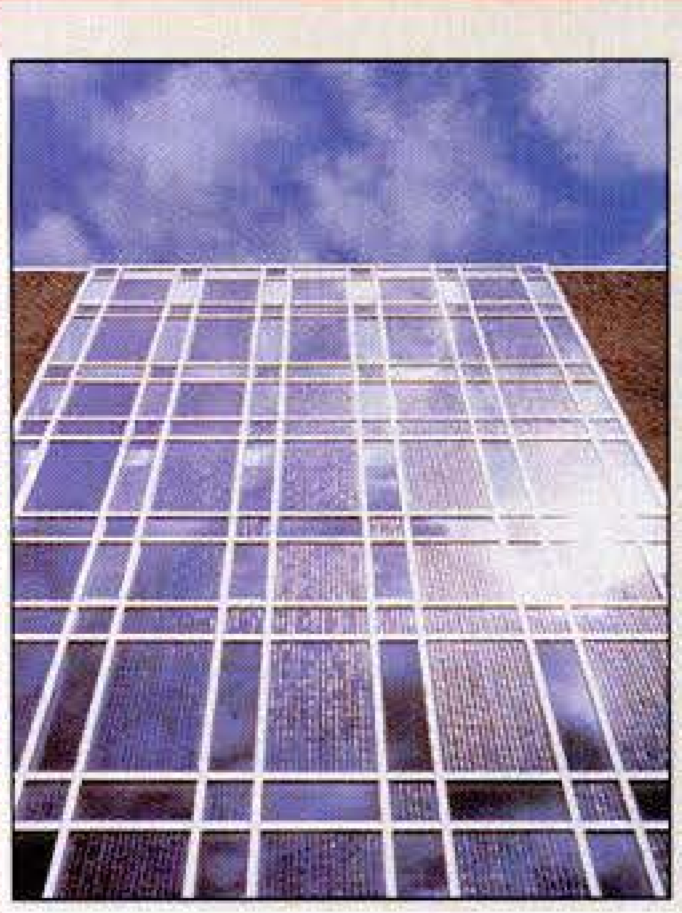
PHOTOVOLTAICS

A NEW SIDE TO SOLAR PANELS

A leading German supplier of glass products has banded with a team of building contractors and architects to pioneer a building product that incorporates photovoltaic solar cells into glass siding. Not only do the glass photovoltaic panels offer more noise insulation than conventional single-pane glass windows, but they convert sunlight into electricity that can then be used to power office buildings or homes.

Optisol, manufactured by Koln-based Flachglas AG, consists of a layer of photovoltaic solar cells sandwiched between two glass panels that are wired to a central energy-management system. If the system produces more energy than the building can use, cables from the management system feed the excess energy back into the public electricity networks.

The high-tech siding doesn't come cheap, however. Joachim Bennemann, managing director of the new solar project, estimates the cost to run between $966 and $1,200 per square foot—which is comparable to the cost of either granite or marble siding but is at least twice the price of normal siding in Germany.—*Wordservice International*



Photovoltaic cells sandwiched between two panes of glass provide good sound insulation and turn sunlight into electricity.

FLAGSOL SOLARTECHNIK

RECYCLING

GREEN CONCRETE

With America clambering for "greener" products, waste leftover from coal incineration could become a key ingredient in a type of concrete new to American shores.

About 70 million tons of so-called fly ash is produced each year by electrical utilities that burn coal for electricity. Autoclaved cellular concrete (ACC) consists of 75 percent fly ash, plus lime, cement, and a touch of aluminum powder mixed with water. When blended together, a chemical reaction takes place that causes tiny hydrogen bubbles to form within the mix. The material rises like bread until it is about twice its original size. It's cut into panels or blocks then popped into an airtight autoclave, or oven, for ten hours to cure. This step precipitates a second chemical reaction that gives the porous material its strength, rigidity, and durability.

The benefits of ACC, used in Great Britain and Germany for about 50 years, are well documented: It's 25 percent lighter than traditional concrete, it's easily worked with carpenters tools, and with insulating R-values of 1.25 per inch, ACC has twice the R-rating of traditional concrete.

"There's nothing dramatically new about ACC other than it being new to the United States," says Bob Sauber, managing director of North American Cellular Concrete in Providence, R.I. "But now with an increasing interest in recycling materials, the increasing cost of wood, and the increasing cost of skilled labor, this material has a good chance in the market." With a cost approximately the same as concrete, Sauber says ACC's first application could be residential foundations.

POWER TOOLS

LOVE AT FIRST CUT

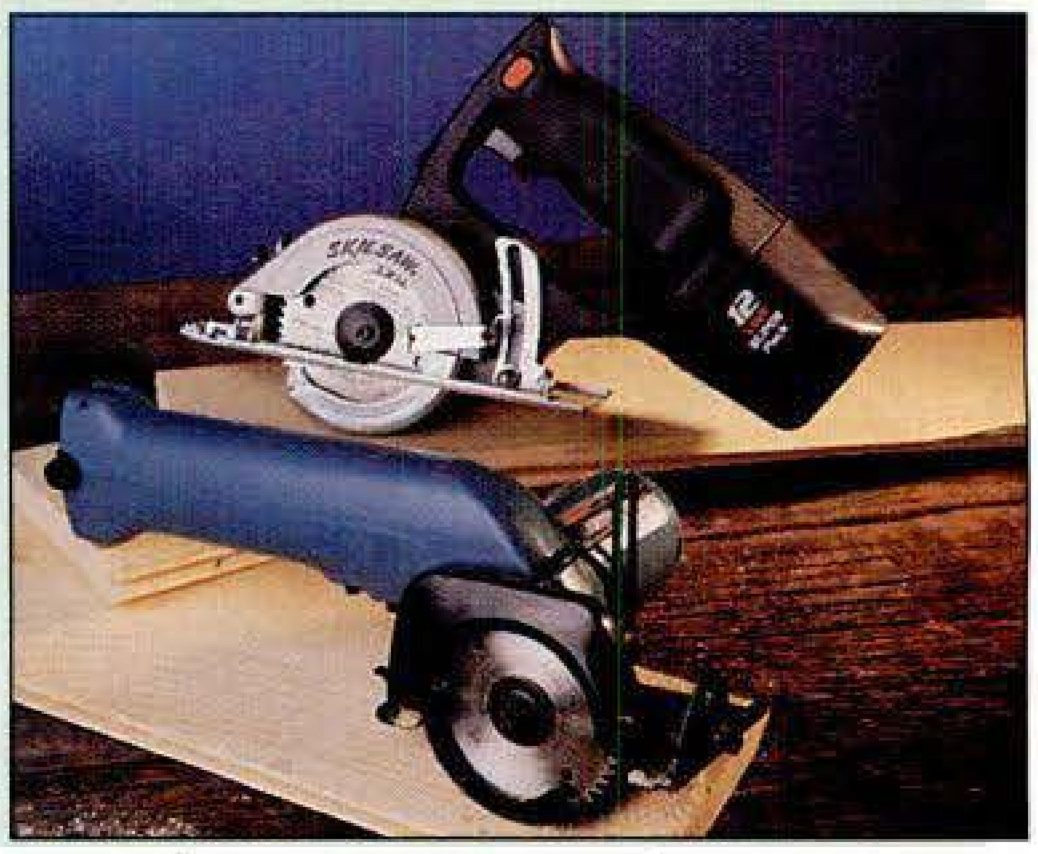
"Cute" is the word that comes to mind when looking at the new generation of cordless carpentry saws. But after trying two different brands, it is love at first cut.

The 4 $^{1}/_{2}$-pound, 3 $^{3}/_{8}$-inch blade Skilsaw hums along at only 1,000 rpm. Still, it makes very precise, vibration-free cuts in wood and laminate that are no more than $^{3}/_{4}$ inch thick.

Skil chose to boost power to 12 volts this year, and refashioned its cordless saw to look more like its full-size circular saws. Handy rip fences can be purchased as accessories.

The slim, battery-in-handle configuration of Mikita's 9.3-volt cordless saw sports a thin kerf (about 0.022 inch), 50-tooth blade that makes quick work of a variety of materials up to $^{3}/_{4}$ inch thick. Aggregate linear cutting footage for the Mikita saw is about 22 feet, with the higher-voltage Skilsaw registering about 28 feet.

The Skilsaw mini carries the blade on the left, making it very easy to keep on the cut line, while the Mikita blade is on the right. Mikita's cordless saw carries a suggested retail price of $265, including battery and charger. The cordless Skilsaw costs about $238 with battery and charger, and comes with a plastic storage box.—*Phil McCafferty*



Both Skilsaw and Mikita cordless saws reach full strength with one hour of recharging.

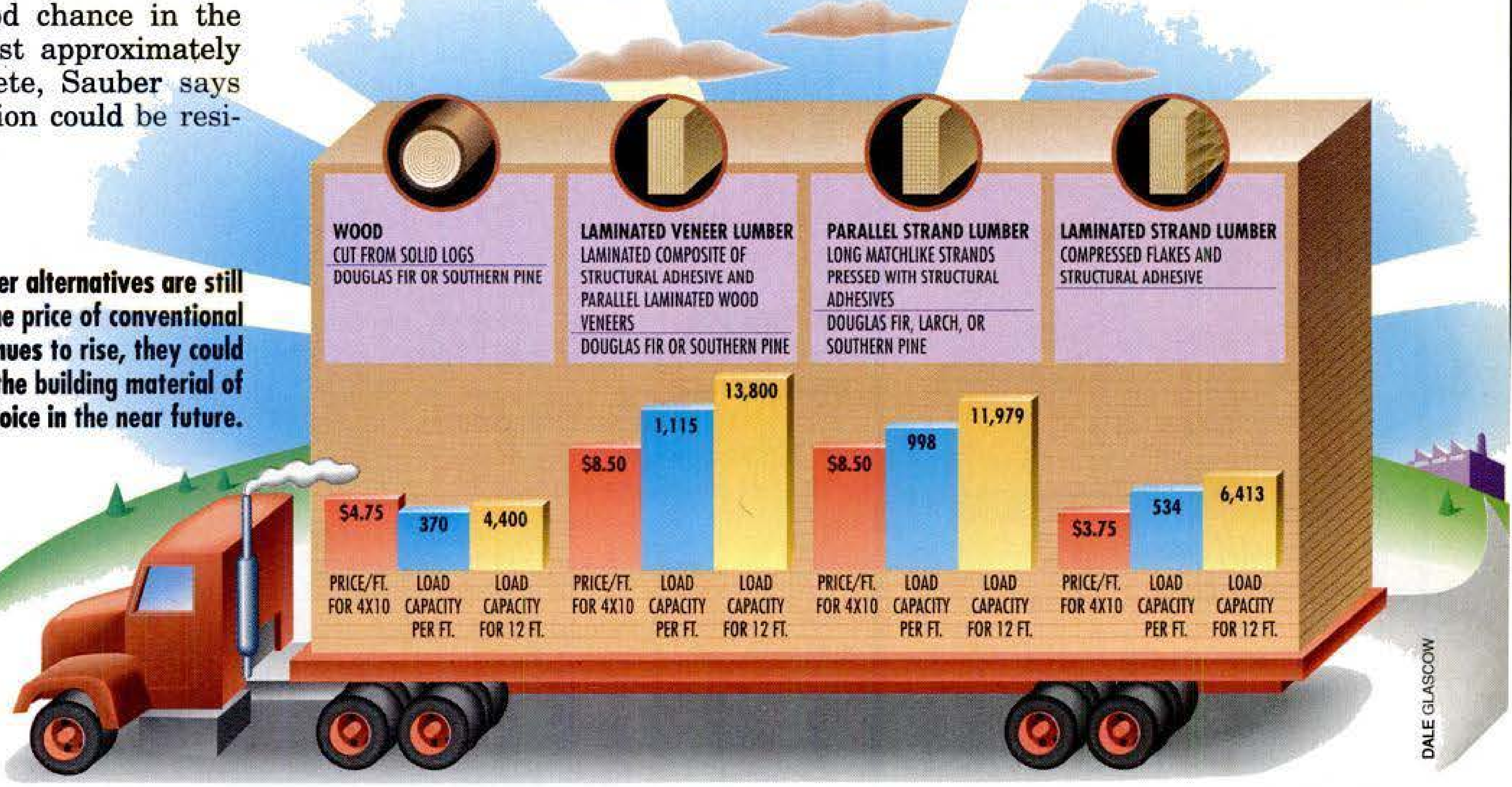
BUILDING TECHNOLOGY

TIMBER ALTERNATIVES

Restrictions on timber harvesting from federal lands are hitting lumber buyers where it hurts most—the pocketbook. Concerns for endangered species and purported misuses of federal lands have made many areas off-limits, causing lumber prices to nearly double in just five months.

The shrinking supply of harvestable trees has also created a brisk market for engineered beams, made by shaving small-diameter trees into thin strands and then reassembling them with structural adhesives. The problem with these products is that they rely on dwindling species such as Douglas fir. A new technology developed by TrusJoist-Macmillan in Boise, Idaho, could take some pressure off those species.

The company's new laminated strand lumber, or LSL, is made from large chips of the fast-growing and plentiful aspen tree. Aspen is too weak for structural use, but LSL technology overcomes this defect by softening or plasticizing the chips with steam, then compressing them to twice their natural density. Because plasticizing does not damage the wood, the resultant beams are twice as strong as equally sized pieces of aspen. And though LSL is far weaker than other engineered beams, it's about equal in strength and price to conventional framing lumber. —*Charles Wardell with Mariette DiChristina*



Laminate lumber alternatives are still costly, but if the price of conventional lumber continues to rise, they could become the building material of choice in the near future.

COMPUTERS & SOFTWARE

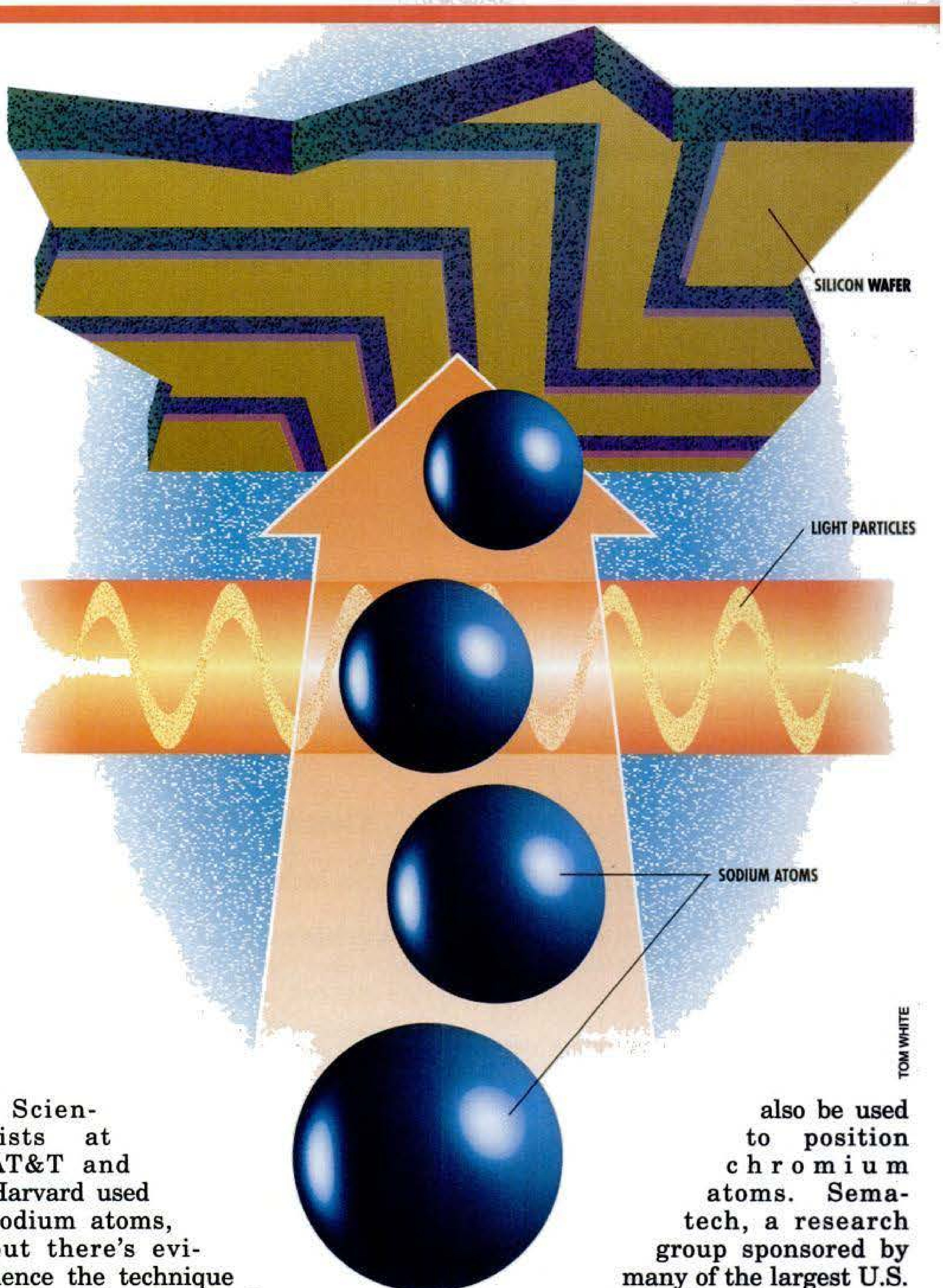
EDITED BY CHRIS O'MALLEY

INTEGRATED CIRCUITS

CHIPS REACH THE ATOMIC LEVEL

The never-ending quest to create smaller integrated circuits has reached a new level: the individual atom. Scientists at AT&T's Bell Laboratories and Harvard University have discovered a way to gently position individual atoms using light beams, raising the prospect of creating incredibly tiny chips.

The new technique uses momentum generated by photons, or particles of light, to move atoms as they are deposited onto the surface of a semiconductor material, such as silicon. A large number of photons, known as a standing wave, can act like a lens to focus atoms and help place them precisely. This process is likely to lead to a new type of lithography—the printing process used to layer electrical components and the circuits connecting them onto chips—that uses finer lines than previously thought practical. In the past several decades, line widths have gone from 25 microns (millionths of a meter) to one-half of a micron, or four times thinner than a human hair. Eventually, the positioning of individual atoms could lead to lines that are thinner than one-tenth of a micron, permitting more circuits to fit on smaller chips.

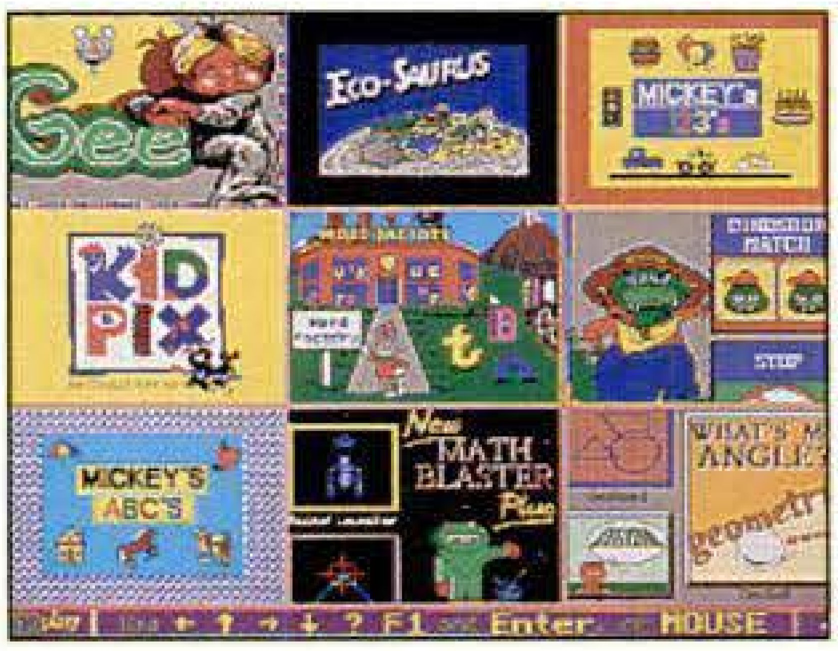


TOM WHITE

Scientists at AT&T and Harvard used sodium atoms, but there's evidence the technique could work with any element. In a separate research effort, scientists at the National Institute of Standards and Technology recently demonstrated that light can also be used to position chromium atoms. Sematech, a research group sponsored by many of the largest U.S. semiconductor makers, is also experimenting with new lithography techniques, including a system called X-ray projection that uses reflected light.

SOFTWARE FOR KIDS

A SAFER, MORE INVITING INTERFACE



EZplay provides children with a pictorial menu to run programs.

Letting children play with PCs that their parents use for work can be confusing to the kids—and upsetting to the adults who may return to find their files rearranged or accidently erased. But new interface software designed for kids is making life a little easier for users both big and small.

KidDesk ($40) from Edmark Corp. of Redmond, Wash., replaces the usual DOS, Windows, or Macintosh interface with a colorful "desktop" screen that gives children access to features such as a message machine and talking clock, while limiting access to the programs used by their parents or teachers. In addition, the desktop can be personalized to display the child's name and picture, though the latter requires a scanner.

EZplay ($40) from JumpStart Software of San Jose, Calif., offers an even simpler approach with its pictorial menu system for DOS. EZplay enables kids to select and run their favorite programs, but parents can restrict access to their programs with passwords.

Though not designed especially for children, Apple Computer sells a program called At Ease ($59) that offers similar features for Mac systems. At Ease lets you create large "buttons" for starting programs and lets you restrict access to certain software and information.

GRAPHICS

IMAGES ON DEMAND

A picture may be worth a thousand words, but it takes just a few words to create a picture with an innovative image database program being developed by Matsushita engineers in Japan.

Rather than simply calling up pictures using their file names or retrieving them through key-word searches, the Matsushita system analyzes the content of plain-English (or in this case, Japanese) sentences and brings appropriate images to the computer screen. In one demonstration using the sentence, "We took a sight-seeing flight over Manhattan and saw the Statue of Liberty," the program first determined which words applied to images and further analyzed the sentence to decide which images should be in the foreground or background. The program then retrieved a photo of the New York skyline featuring the Statue of Liberty and placed an oversized airplane in the middle of the picture.

The first commericial product based on the technology may be two or three years away. Eventually, Matsushita engineers say they expect image-matching features to be woven into a variety of word processing, desktop publishing, and multimedia applications.—*Dennis Normile*

Matsushita's image-generating software analyzes typed requests and produces a matching picture from its database of graphics.

PROGRAMMING

WEIRD-WARE WANTED

If you've got programming skills and a vivid imagination, the folks who stage the San Diego Computer Fair are looking for you. The annual fair, to be held Sept. 10 to 12, is sponsoring a Weird Software competition. Entries are due by July 30 and must be on 3.5-inch disks in either DOS or Macintosh format. Cash, T-shirt, and book prizes are awarded to winners, and all entrants receive a "certificate of weirdness." One hint: Among last year's winners were a screen-saver utility program that displayed bungee-jumping cows and a program that was designed to detect the presence of aliens. Submissions should be sent to 1993 Weird Software Contest, 3655 Ruffin Rd., Suite 100, San Diego, Calif. 92123. Include your name, address, and telephone number, as well as a brief description and the price of your less-than-normal creation.

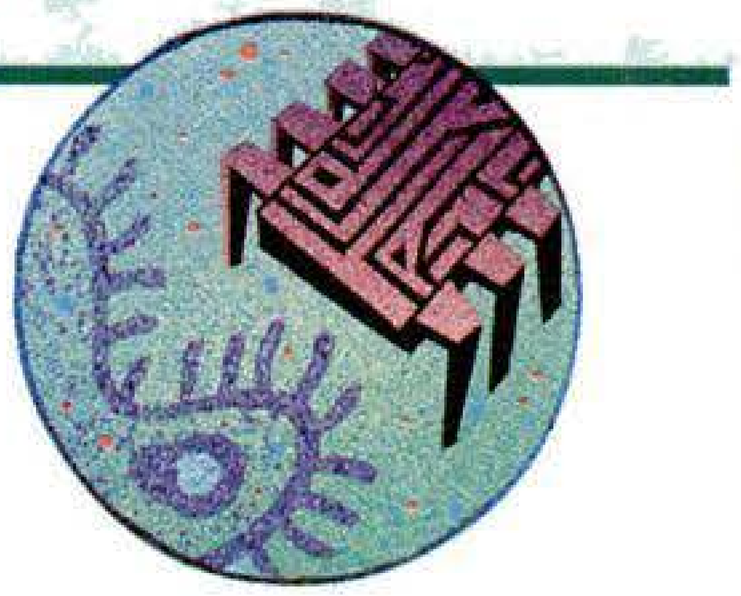
DIAGNOSTICS

HOW UPSET CHIPS SPELL RELIEF: NUCLEAR MICROPROBE

Watch your computer carefully this year: There's a good chance it will suffer a "single event upset," or SEU, within the next 12 months, say physicists at Sandia National Laboratories in Albuquerque, N.M. Fortunately, they're working on a solution for these high-tech hiccups.

The sources of the trouble are energetic ions from contaminants that are inevitably contained in an integrated circuit's ceramic capsule. The collected electrical charge of these ions can collide with one of the microscopic features on the chip, with random and undesirable results. A single pixel on your screen might switch colors for a second, for example, or one character in a document you're writing might change. The ion-effect is not a big problem with PCs. But it is potentially a problem with highly sensitive computers that are sent into outer space, where there is more radiation and where SEU problems have been documented.

Researchers at Sandia have developed a device called a nuclear microprobe that can take micron-resolution pictures of a chip's features and discover which parts are damaged by SEUs and which shrug them off. Armed with this knowledge, chip makers may be able to design new integrated circuits that are more resistant to SEU failures or learn how to work around them.
—*Jonathan D. Beard*



MARTY BRAUN

MEMORY

ORGANIC COMPUTING

Could bacteria someday replace the memory chips inside computers? A discovery by Robert Birge, a Syracuse University researcher investigating molecular electronics, raises just such a possibility.

Birge recently used a nanometer-size protein called bacteriorhodopsin, derived from a saltwater bacteria, to successfully simulate computer memory. The protein responds to changes in light and can obstruct or conduct currents. Crossed laser beams aimed at a three-dimensional matrix of the protein molecules stimulate electrical pulses similar to the on-off state of computer bits. Organic molecules are not only plentiful and inexpensive, they may also be as much as five times faster than electronic memory.
—*Patricia Barnes-Svarney*

SOFTWARE

SUMMER CAMP COMES HOME

Now summer camp can come home to your kids. Apple Computer is teaming up with the American Library Association to offer parents and children a free Performa Summer Home Camp Kit, a collection of 31 "summer boredom busters" that can be done on a computer. (Performa is the name of Apple's new series of inexpensive Macintosh models, but any type of computer will do.) A summer reading list and suggestions for local outings are also included. The kit can be obtained by writing to Performa Summer Home Camp Kit, 55 Union St., San Francisco, Calif. 94111.

ADVERTISEMENT

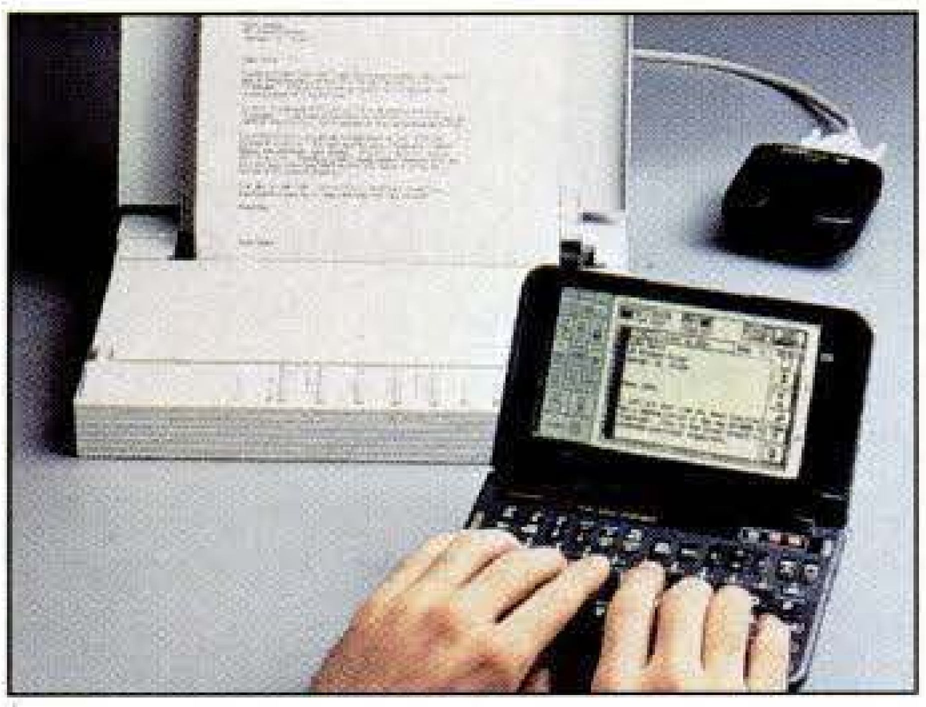
SHARP WIZARDRY

Taking Your Show On The Road

In business today, computers are indispensable for managing the flow of information. But even with the availability of computers, until now pen and paper remained the fastest, most convenient way to capture our ideas and inspirations from moment to moment.

Put pens and computers together in a portable, pocketable form and you would have the world's most efficient business tool—that was the thinking behind Sharp Electronics Corporation's Wizard OZ-9600. But just how efficient is it? And how can it make you more productive? Like this:

- You're meeting with a business contact to develop an idea. You take out your OZ-9600 and touch the screen's *Scrapbook* icon. Using the stylus or the back of a pen, you write a few notes, then hand your contact the Wizard and he draws in the details—right on the screen. You store all of this information, including the sketch, in the unit's memory.
- With an optional modem, you connect the OZ-9600 to a phone and instantly E-mail the information to another source for a second opinion. Then you touch the screen to open *Notebook*, and type a formal business letter describing your idea. Using another accessory, an infra-red receiver attached to a standard computer printer, the Wizard wirelessly transmits your proposal directly to print.
- You quickly move the business letter to a folder in the OZ-9600—one that looks just like the folders in your office file cabinet. Then you type in a *To Do* entry so the OZ-9600 will remind you to complete your project. You also transfer a copy of the file directly to your office computer for safekeeping.
- You close your Wizard OZ-9600 and slip it into your jacket pocket or purse. Then you invite your contact to join you for lunch—to celebrate the success of your new venture.



Wireless infra-red technology lets the Wizard OZ-9600 transmit to computers and printers without clumsy cables.

SHARP®

COMPUTERS & SOFTWARE

SMART CARDS

MEDICAL RECORDS IN YOUR WALLET

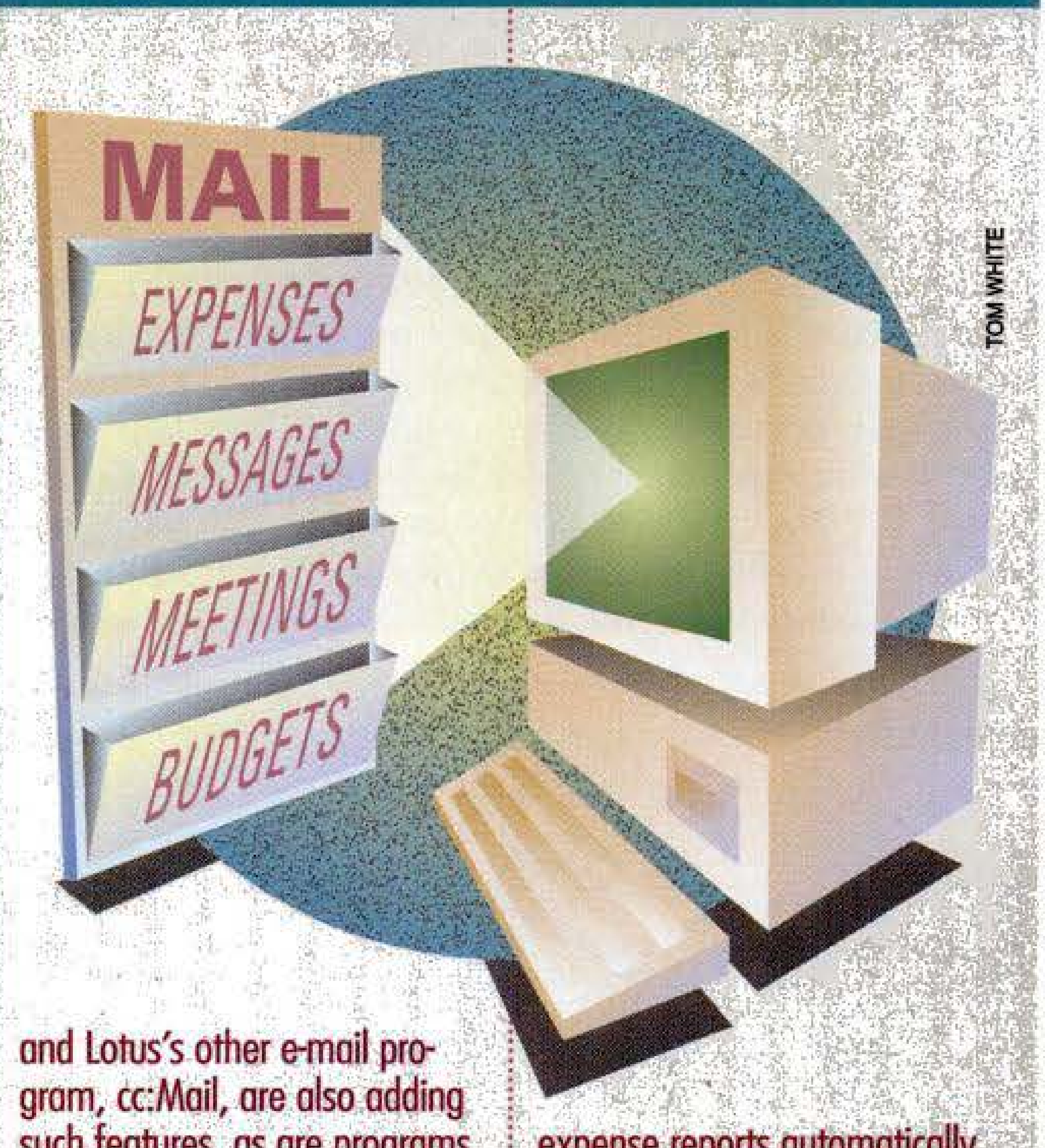
Imagine a device no bigger than a credit card that contains all of your medical records and health insurance information. Now imagine the benefits: an emergency-room doctor knowing what drugs you are allergic to even though you're unconscious, for example.

Such devices could start popping up in U.S. hospitals within a few months, if a new software system designed by AT&T catches on. Using the company's Smart Card, the program stores up to four million characters worth of insurance data and critical medical facts, such as heart conditions or drug prescriptions. Moreover, the system can send data electronically to insurers, eliminating tedious forms. The card would also provide for some control over who reads what: Hospital administrators, for instance, might only be allowed to look up insurance data, while doctors could read actual patient histories.

AT&T isn't without competition. A similar-size optical card from Canon will be used for new medical-recordkeeping systems in several European countries, and a California trial using the Canon card is set to begin later this year. Proponents claim medical cards could save hundreds of lives—and billions of dollars—each year.
—Robert Langreth

COMMUNICATIONS

E-MAIL GETS SMARTER



TOM WHITE

Traditionally, electronic mail has meant sending and receiving messages between computers. It still does, but so-called smart e-mail software is broadening the medium's role to include tasks such as screening your messages, scheduling meetings, and filing expense reports.

On a personal level, these more sophisticated e-mail programs enable you to set up rules to sort and prioritize your messages according to their sender, subject, or other criteria. E-mail from your boss might be deposited in a high-priority folder for immediate reading, for example, while messages from others might be stored in folders for later perusal. You can even set up a filter to weed out electronic junk mail, such as solicitations.

BeyondMail, from Beyond Inc. of Cambridge, Mass., and Personal Information Agent, from J&T Associates of Saline, Mich., are two of the programs that specialize in these sorting features. Both work with Lotus's Notes software, a "groupware" product that combines e-mail and database capabilities for PC users linked by a network system. Notes itself and Lotus's other e-mail program, cc:Mail, are also adding such features, as are programs from Microsoft and Oracle.

On a group level, programs such as Microsoft's Schedule+ and On Technology's Schedule-Maker now enable you to plan meetings, check the calendars of coworkers, and reserve conference rooms via e-mail. So-called workflow software, such as Reach Software's Workman and Action's Workflow Management System, replace reams of paper with electronic forms and automatic message forwarding. By establishing certain rules in the software you could ensure, for example, that expense reports automatically go to the boss for approval before being passed on to the accounting department.

Coming soon is a new generation of "mail-enabled" spreadsheets, word processors, and other programs that will let you send messages and files without using special e-mail software at all. Built-in communications features will enable you to send budget figures to a colleague, for instance, by making a simple menu choice within the spreadsheet program.
—Suzanne Kantra

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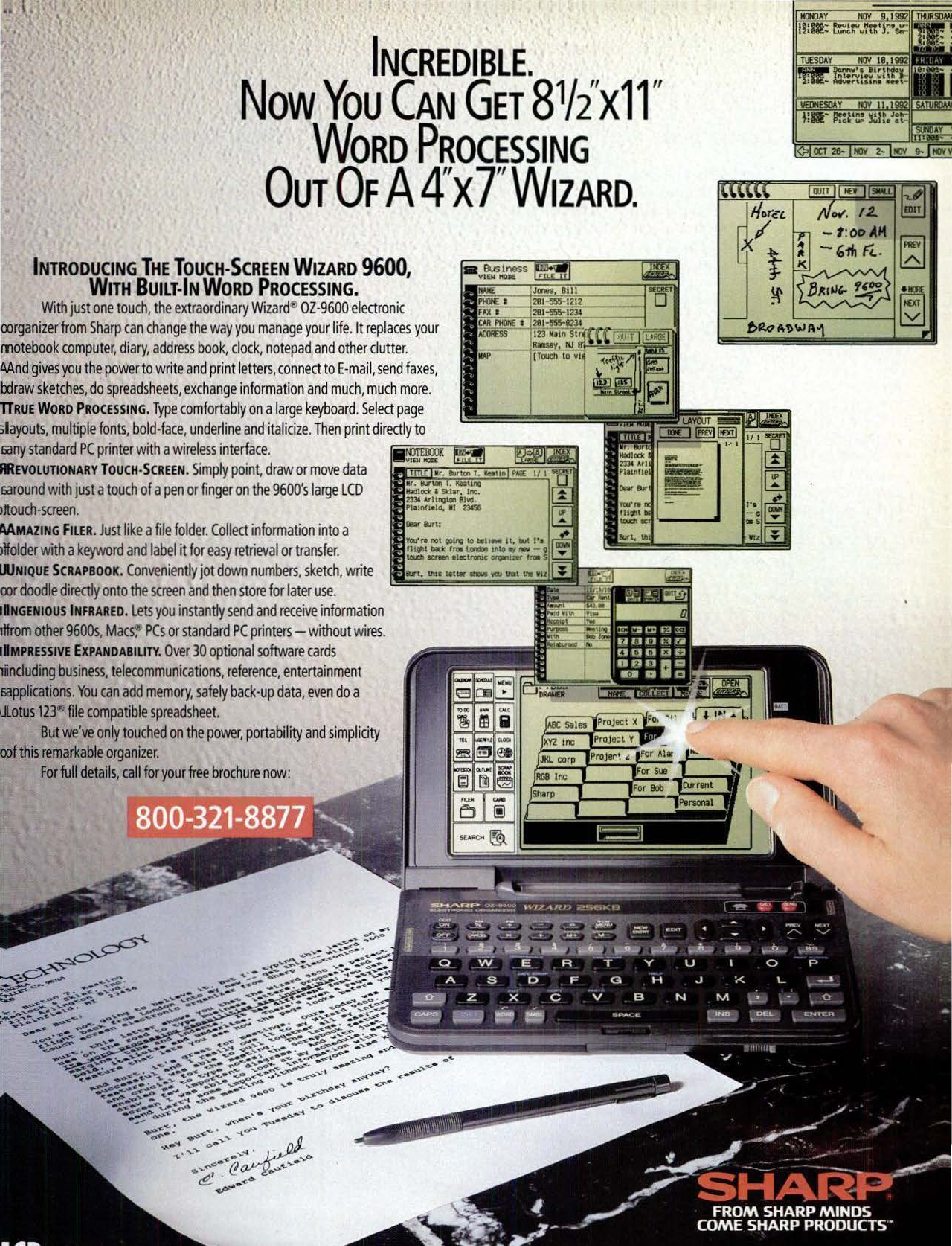

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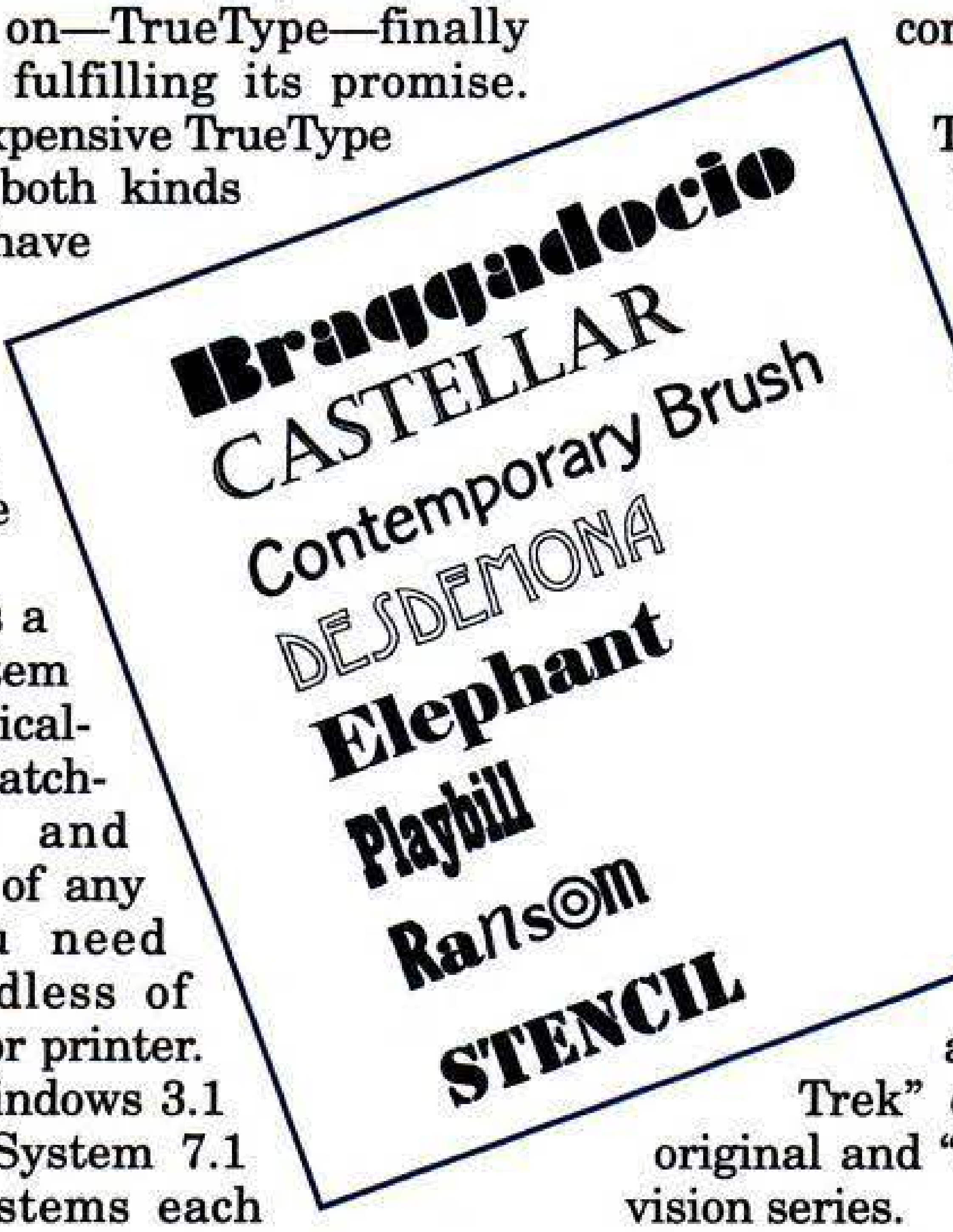
FONTS

TRUETYPE COMES TRUE

Three years after Apple and Microsoft joined forces to promote the idea of using the same font technology in both Macintosh and Windows-based computers, the format they agreed on—TrueType—finally seems to be fulfilling its promise. Dozens of inexpensive TrueType packages for both kinds of computers have appeared in the past few months, making the font a true standard.

TrueType is a software system that automatically generates matching screen and printer fonts of any size as you need them, regardless of the program or printer. Microsoft's Windows 3.1 and Apple's System 7.1 operating systems each include TrueType capabilities and a few TrueType typefaces. More recently, Microsoft has released a pair of TrueType Font Packs for Windows and a matching collection for the Macintosh called the TrueType Master Set, making it easier for Windows and Mac users to swap documents. Apple sells a TrueType Font Pack of its own, as do many third-party companies.

Not all of the TrueType collections contain business-letter fonts. One company, Bitstream Inc. of Cambridge, Mass., recently introduced a series of just-for-fun fonts that feature cartoon characters from the "Jetsons," the "Flintstones," and "Looney Tunes." Two additional font packages feature "Star Trek" effects from both the original and "Next Generation" television series.



BULLETIN BOARDS

THE ECLECTIC, ELECTRIC CIRCUS

There's an electronic bulletin board system (BBS) for almost every taste, and AmeriBoard of Indiana, Pa., has amassed a national database of them—more than 6,000 in all. Using a PC and modem, you can dial up the AmeriBoard BBS (412-349-6862) to get a copy of the list. (Every BBS uses the modem settings 8,N,1.) Below is a sampling of what you'll find.—*S. K.*

BBS NAME	TOPIC	NUMBER	MAX. BPS
Earl Weaver Baseball League	Baseball happenings	415-864-4248	2,400
Lefthanders World	Southpaw tips, humor	415-726-7932	2,400
Public Seismic Network	Earthquakes, volcanoes, related issues	408-226-0675	2,400
Green Thumb	Gardening ideas	206-255-0387	2,400
The Pacific Sunstone	Chemistry, physics, other sciences	415-359-6036	9,600
Music Connection	Concert news, videos, charts, MIDI files	404-936-0550	9,600
New Parents Network	Support groups, family services, related topics	602-326-9345	2,400
U.S. National Crime	Latest scams, warnings, experiences, conferences	602-846-4470	2,400
M*A*S*H 4077	Talk about TV series	305-981-9927	9,600
Hitchhiker's Guide	UFOs, paranormal events	805-944-2994	9,600

PRINTING

HELLO COMPUTER? I THINK I'M OUT OF TONER

Computer printing has long been a one-way street. The PC sends data to the printer, and the printer puts it on paper. But some new printers are talking back, thanks to bidirectional parallel ports that let them communicate with their masters—letting you know they're out of paper or toner, or that a page has jammed.

Newer laser printers from Compaq, Lexmark, and Hewlett-Packard already sport "bi-di" ports, and many forthcoming laser, ink-jet, and dot-matrix printers are expected to have them too. If you own one of Hewlett-Packard's older LaserJet II or III models and use the Windows operating system, you have another option: Microsoft's Windows Printing System uses software that endows these printers with bidirectional capabilities.

ON-LINE SERVICES

TALK RADIO GOES DIGITAL

Move over, Larry King and Howard Stern. The latest talk radio sensation isn't even on the radio—it's on the Internet computer network—and you'll need a modem to tune in.

A project called Internet Talk Radio recently began "airing" its first on-line show, a weekly half-hour, high-tech interview program called "Geek of the Week." The program is distributed in digital format over the Internet system. Internet is an electronic network used mainly by universities, government agencies, and technology companies, but it can also be accessed through mainstream services such as CompuServe and America Online. To hear the show, you must use your modem to retrieve a large computer file and have a PC or Macintosh equipped with a soundboard and speakers (or headphones) to play back the digital "tape." Once it's stored on your hard disk, which requires 15 megabytes of free space, you can fast-forward and rewind the show, similar to an audio tape.

Future shows will include book reviews and short features on technology subjects. While the content of Internet Talk Radio may have limited appeal, its developers see the potential for mass-market news and entertainment over computer networks. Eventually, movies and TV shows might also be distributed.—*Jon Pepper*

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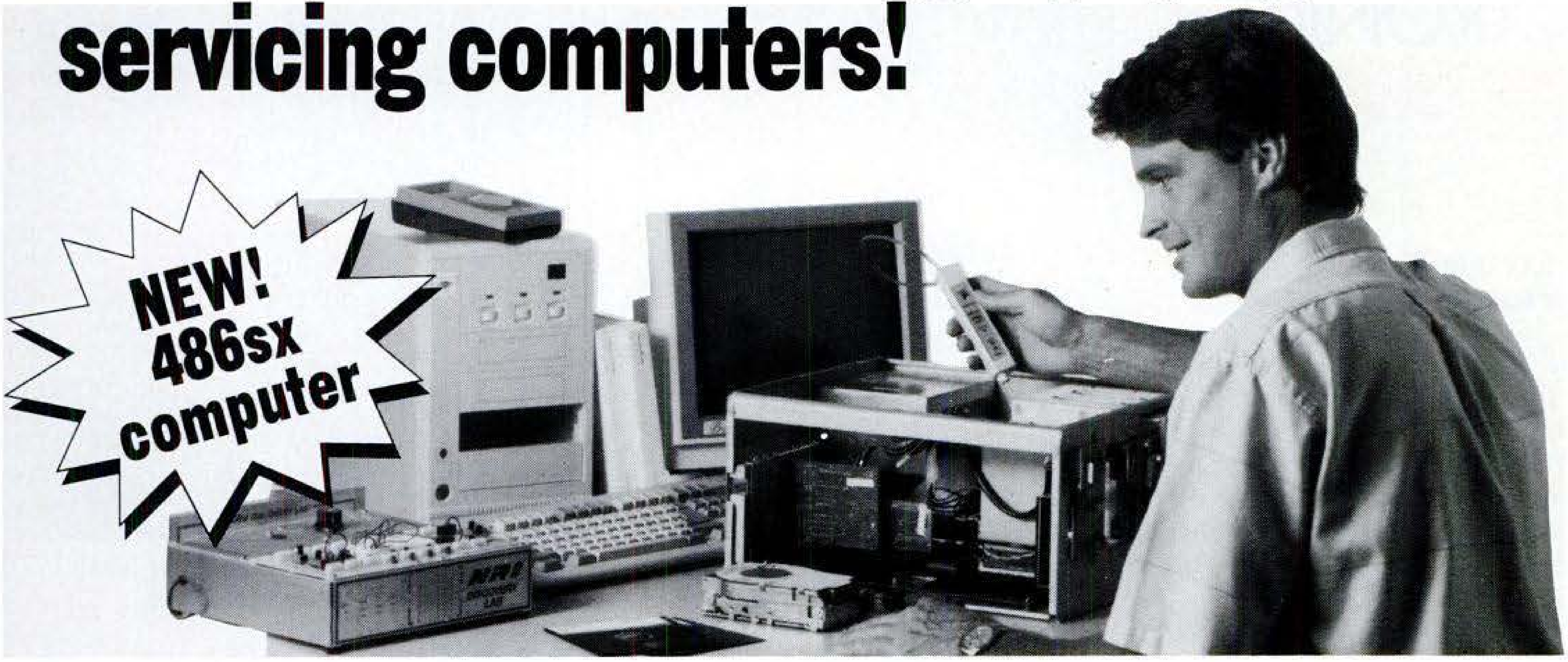

BUILD YOUR OWN COMPUTER

Ask anyone in the field. They'll say the best way to learn to service *today's* computers is to actually *build* a state-of-the-art computer from the keyboard up. And with NRI, you train with and keep the powerful 486sx, 1 meg RAM, 32-bit CPU computer system — the most powerful computer available in *any* home study course.

You start by performing hands-on electronics experiments with your NRI Discovery Lab and digital multimeter. You then learn to build and test the powerful 486sx/25 MHz computer and install the 1.2 meg, 5-1/4" floppy disk drive, learning disk drive operation and adjustment. Later, you dramatically improve your computer's data storage capacity by installing a powerful 80 meg IDE hard drive. You even learn to diagnose and service virtually any computer problem with the extraordinary R.A.C.E.R. plug-in diagnostic card and QuickTech diagnostic software included in your course.

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LEARN FROM YOUR OWN PERSONAL INSTRUCTOR

Prepare for today's computer service opportunities in the privacy and convenience of your own home — with the support of your personal instructor and NRI's team of technical professionals behind you every step of the way. NRI's experts are on hand to guide you from the simplest to the most complex lessons, and they're available to assist you with technical support long after you've graduated.

START YOUR OWN BUSINESS

The Department of Labor forecasts over 220,000 jobs for computer service technicians by the year 2005 — a 38% increase over today's level. With the right training and skills, you can cash in on this wide-open opportunity and become a high-paid computer service technician — even start a computer service business of your own. You'll be well prepared for any job that comes your way — continuously drawing on the real-world experience of your NRI training.

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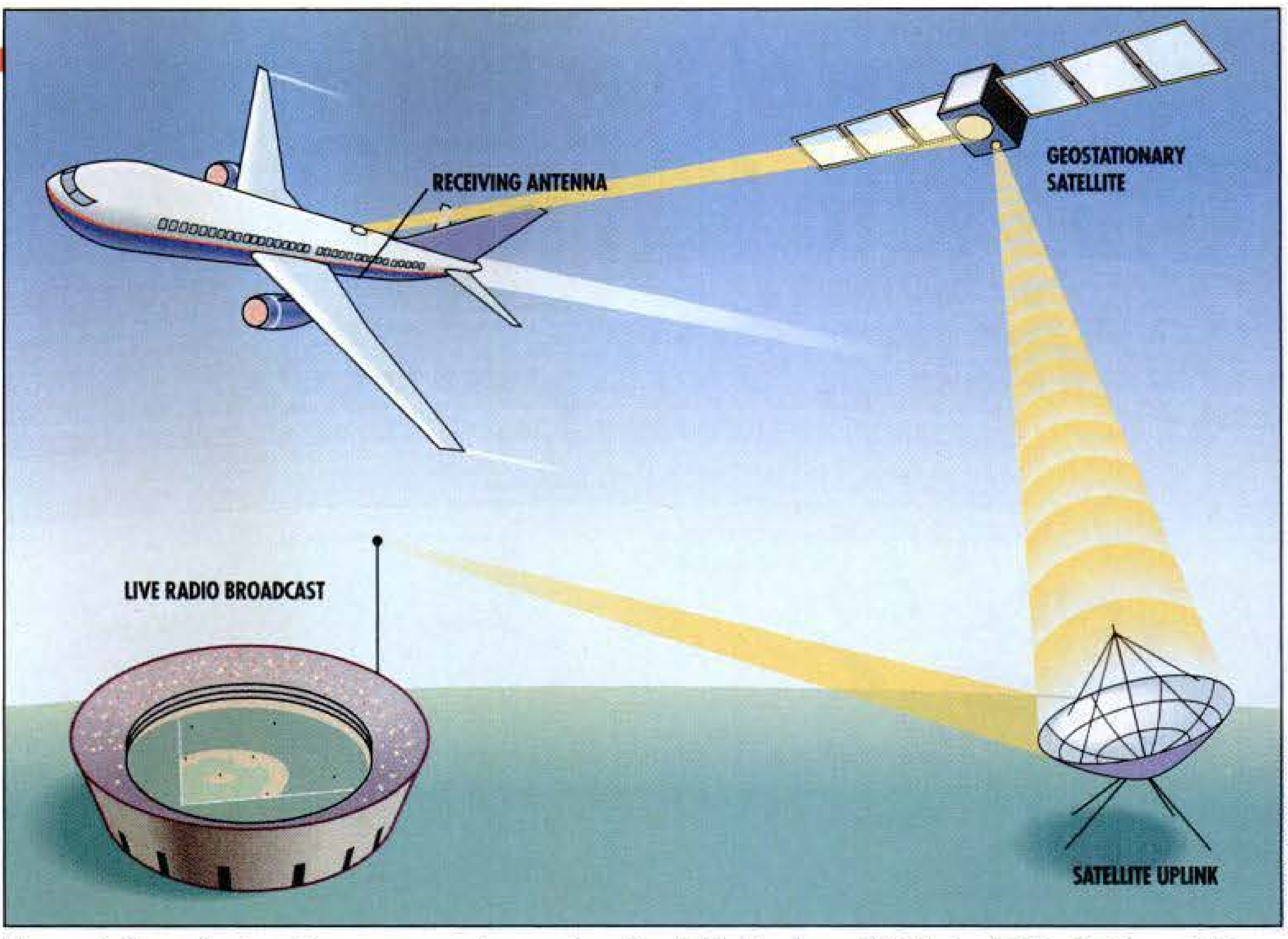
ELECTRONICS

EDITED BY MICHAEL ANTONOFF



Some airplanes feature live programming, such as SportsRadio, from USA Today's Sky Radio, which provides CBS Radio Network baseball coverage. Other scores are updated every 15 minutes.

COMMUNICATIONS

LISTEN TO THE FRIENDLY SKIES

If you've traveled on a jetliner, you know the problem: You make do with the least offensive channel of canned music. Now, USA Today's Sky Radio provides live programming on some flights. A second system, FlightLine-On-The-Air, could be available by summer's end.

Digitized, compressed radio signals created at Sky Radio in Arlington, Va., are sent to a geostationary satellite. On the top of the plane, a specially designed antenna uses flight information to stay directed at the satellite while in the air. A receiver relays the signal to the plane's existing audio system.

The service, with three channels for news, sports, and opinion programs, is available within the continental United States on more than 200 United, Delta, and Northwest aircraft. Passengers may be charged a few dollars to use the headphones.

FlightLine-On-The-Air, the second system, is being developed by In-Flight Phone Corp. of Oakbrook Terrace, Ill. Using equipment developed by Harris Corp., ABC Radio studios will also digitize, compress, and transmit radio signals uplinked to satellites. The satellites will relay the signals to 90 U.S. and Canadian ground stations. These stations will then rebroadcast the data streams continuously on a UHF frequency. Under the plane, a four-inch-long antenna will pick up the signal. For smooth reception, one receiver will accept the signal while a second searches for the next transmitter.

Using a headset and liquid-crystal display on each seat back, passengers will select from 12 channels for talk radio, news, sports, or music. The audio will be free, with charges for some sports events.—*Mariette DiChristina*

TELEVISION

SPLIT PERSONALITY

No more arguing over whether to watch the ballet or ball game. The CinemaScreen 16:9 widescreen television offers a Split Screen feature so you can divvy up screen real estate equally for both pictures—and hear two simultaneous channels of sound—on the same TV. The audio portion of one show is heard from the television's speakers, while the audio of the other program comes through optional headphones. Call it picture-by-picture (PBP).

Split Screen works with built-in twin tuners that also enable picture-in-picture (PIP) and picture-outside-picture (POP) ["Electronics Newsfront," June]. Another feature called Channel Guide scans all available programs and displays snapshots of nine channels at a time.

Two shows can be seen—and heard—with the Split Screen feature.

The CinemaScreen TVs, available under the RCA and ProScan name, cost approximately $5,000. Of course, buying two conventional sets for his and her viewing is a whole lot cheaper. But then, that wouldn't be sharing. —*Marcelle M. Soviero*

R & D

VIDEODISC RECORDER GETS GREEN LIGHT

Samsung has developed a new digital videodisc recorder (D-VDR) that records and plays up to 110 minutes of video on a disc less than half the diameter of today's record-album-size laser-disc platters.

The key to D-VDR technology is a high-power laser diode, a semiconductor device that generates laser light, and an optical module, according to Samsung Advanced Institute of Technology (SAIT), the research and development arm of the South Korea-based Samsung Group. SAIT uses a green light laser. Its beamspot size has a 532-nanometer wavelength —the green spectrum of light—that consolidates the space used, thereby producing a sevenfold increase in the memory capacity of a 5.25-inch magneto-optical disc. By comparison, today's laser-disc players hold only 60 minutes of analog video on a 12-inch disc and do not record.

The other three technologies that make the D-VDR possible are Samsung's own data-compression technique, mark edge recording, and a constant linear velocity (CLV) spinning method. Mark edge recording allows for high-density recording by counting from the edge, rather than the center, of the marked recording elements, which are, in this case, laser beams.

The CLV disc spinning method maintains the constant linear velocity of the disc, unlike the constant angular velocity method, which would reduce the running time of D-VDR to 70 minutes.

SAIT researchers who took part in the $25 million project say the new D-VDR, which should be available by 1995, is a huge improvement on existing alternatives. SAIT has applied for patents in the United States, Japan, and South Korea.—*Wordservice International*

A Breakthrough In Cordless Phone Technology

The Escort 9000 Series is the next generation of cordless phones. The first consumer phones to use Digital Spread Spectrum technology (patent pending), they set a new standard for range, clarity and security.

RANGE – the farthest

With up to four times the range of ordinary cordless phones, Escort's 9000 Series gives you unprecedented freedom and mobility. Just pick up the handset and go – room to room, around the yard – even around the block.

CLARITY – the clearest

By utilizing the most advanced digital technology (similar to that used in making CDs), Escort's 9000 Series provides incredibly sharp sound quality. No static. No echo. Just clear, crisp conversations.

SECURITY – the safest

Escort's 9000 Series cordless phones keep private conversations private. No unauthorized listening. No third party interference. Just absolute privacy. And only Digital Spread Spectrum technology provides this level of security.

Digital Spread Spectrum (DSS) Technology

DSS is used by the US Military to ensure absolute security in field communications. By rapidly and randomly changing frequencies over a wide (26 MHz) bandwidth, total security is assured. And digital technology embeds microprocessors to eliminate unwanted line noise for crystal clear sound.

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Simply put, if the Escort 9000 Series cordless phone isn't the best cordless phone you've ever used, return it within 30 days for a refund. Period.

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The Escort Series consists of Escort 9000 in White and Escort 9010 in Dark Gray.

The Escort 9000 Series phones operate with the ease and convenience of corded phones. With Automatic Answer, you can take calls by just picking up the handset from the base (there are no buttons to push). They operate in three positions: lay-down (like a standard phone), stand-up (pictured left) or on the wall. In addition, the Escort 9000 Series phones are loaded with features:

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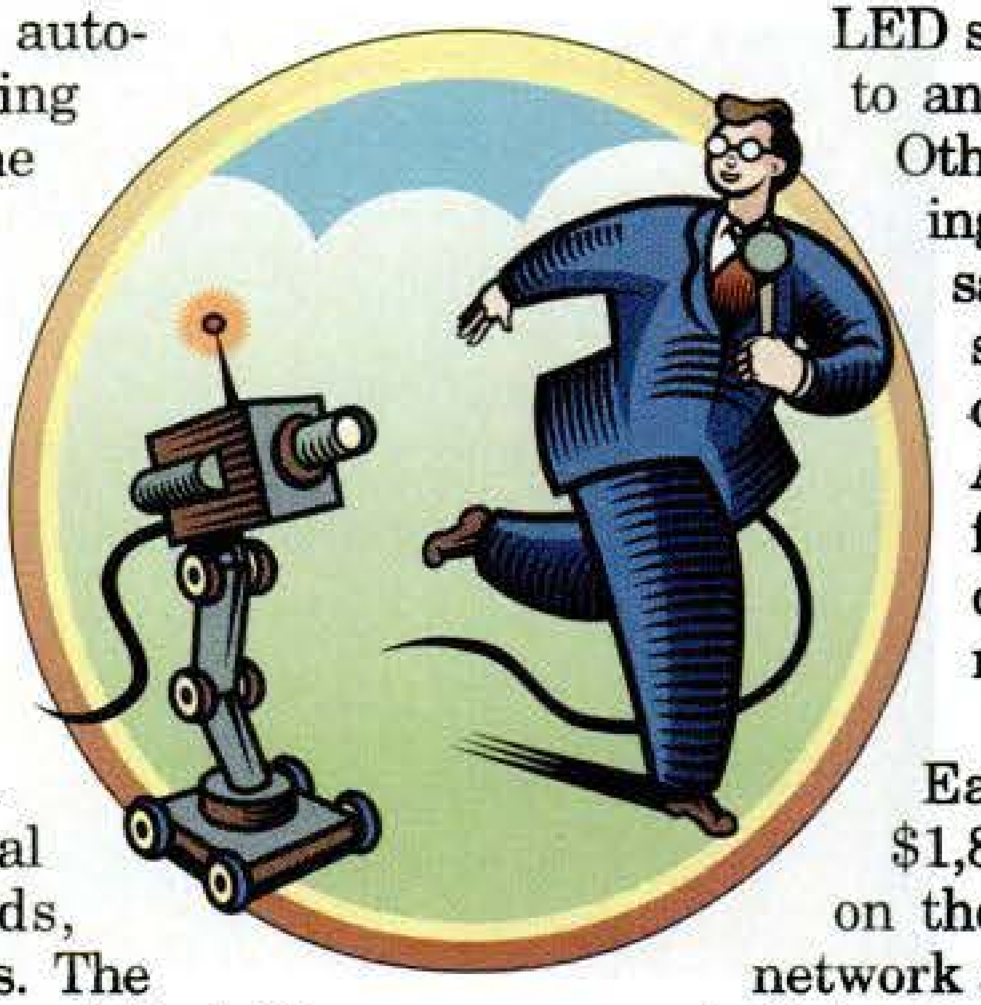
ROBOTICS

THE CAMERA THAT FOLLOWS YOU

The first rule TV performers learn is to look straight at the camera. Now there is a television camera that looks straight at the performer, automatically tracking him without the need for a human operator.


PETER HOEY

Developed at NHK, Japan's public broadcaster, the system is composed of a TV camera, a workstation containing special graphics boards, and servomotors. The workstation is "taught" which image to follow by placing the subject in position before the camera and executing a learning routine. Thereafter, the workstation continuously analyzes the video signals and through the servomotors, controls the tilt, pan, and zoom of the camera to maintain the position and size of the image.

NHK says that the system can be trained to follow any image, but the program presently uses the shape and color of a face. These elements are more constant than, say, a performer's wardrobe.

The system is expected to be used as a second camera for news programs and talk shows where there is limited movement. The types of programs will expand as the system's smoothness and speed improve.—*Dennis Normile*

CELLULAR PHONES

THREE WAYS TO KEEP IN TOUCH

Shrink a desktop telephone, a cordless phone, and a cellular phone into a single, sleek, eight-ounce package and you have the new FreedomLink phone system from Southwestern Bell and Panasonic. The system lets you take calls while roaming the office halls or while heading across town, without switching phones.

The secret? Inside your office, a book-size cellular base station beams signals between the portable phone and the regular telephone network. If you decide to leave the building, the telephone then automatically switches over to an external cellular network.

I tried the system at New England Deaconess Hospital in Boston. A call from New York to nurse manager Chris Boylen's office rang on both her desk and pocket phones. The connection on the lightweight portable set was clean and didn't fade as I walked around.

When I went outside, a signal on the LED screen indicated the handoff to an external cellular network. Other than that change, receiving and making calls was the same as it was inside. Outside, the handset operated on its own cellular number. And with call forwarding from your desk phone, you don't need to give out a series of phone numbers.

The drawback is price. Each phone costs between $1,800 and $2,500, depending on the size of the building; the network software starts at $15,000. A flat rate of $10 to $40 per month covers an unlimited number of calls made on the internal cellular network; those made using an external cellular system are billed at regular rates.—*P. J. Skerrett*

HOME VIDEO

FULL-MOTION CD-I

One of the limitations of CD-I (compact-disc interactive) machines is that they lack full-motion video. Now, CD-I's manufacturer, Philips Consumer Electronics Co., has broken that barrier with a $250 add-in cartridge that enables existing machines to run full-screen television-quality video at 30 frames per second.

With full-motion video, a biography on CD-I could include full-screen news clips, for instance, while one without full-motion would be more likely to contain only still photographs or video clips shown at a jerky 10 to 15 frames per second in a small window.

The consumer CD-I players, models 220 and 910, retail for $599 and come without displays because they plug into TV sets. The newest portable, the model 350 ($2,195), has a six-inch, active-matrix color LCD screen. It's aimed at businesspeople who make presentations or training videos. CD-I titles that use full-motion video should show up on retail shelves this summer.—*Sandy Reed* PS

VIRTUAL REALITY

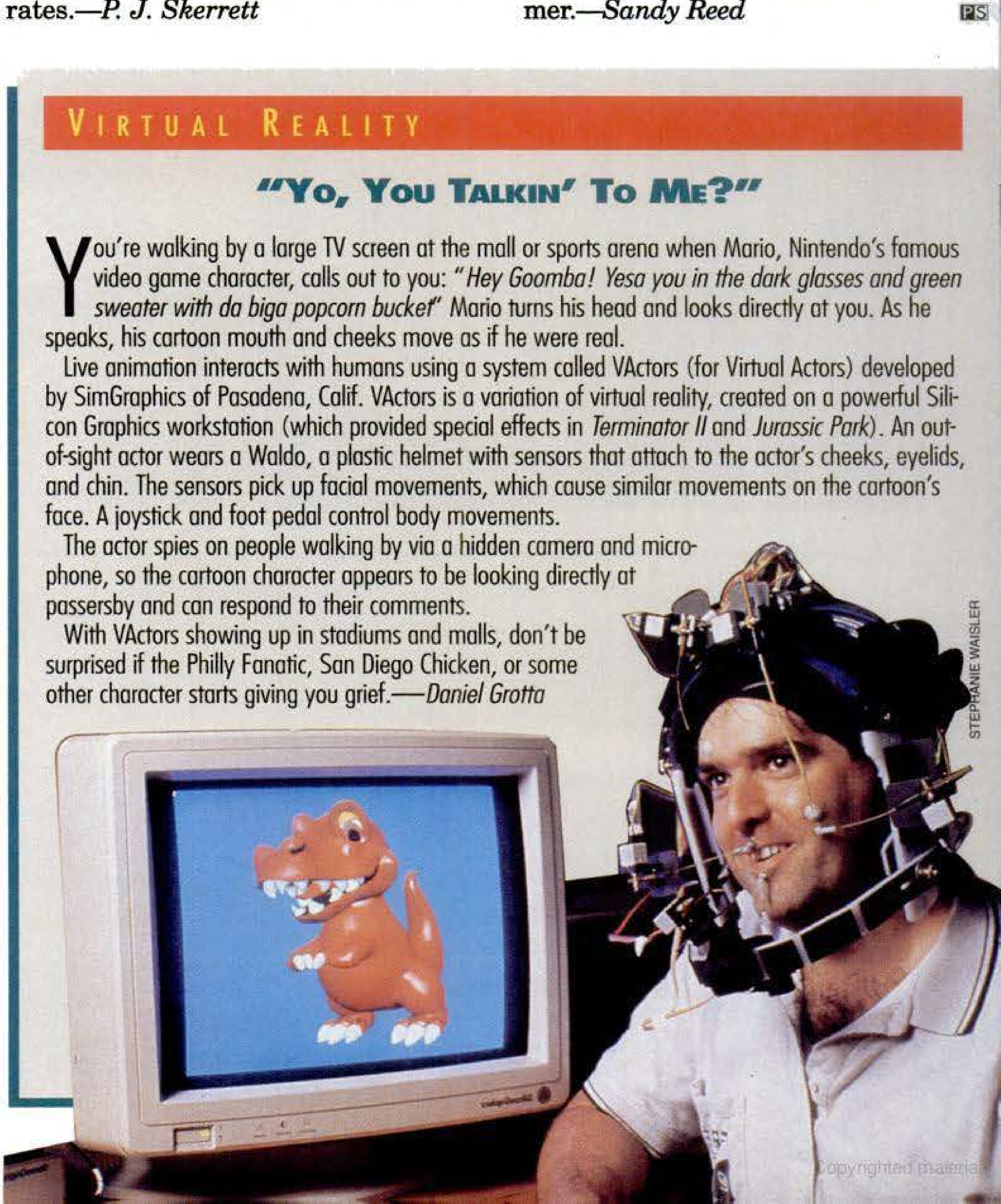
"YO, YOU TALKIN' TO ME?"

You're walking by a large TV screen at the mall or sports arena when Mario, Nintendo's famous video game character, calls out to you: *"Hey Goomba! Yesa you in the dark glasses and green sweater with da biga popcorn bucket"* Mario turns his head and looks directly at you. As he speaks, his cartoon mouth and cheeks move as if he were real.

Live animation interacts with humans using a system called VActors (for Virtual Actors) developed by SimGraphics of Pasadena, Calif. VActors is a variation of virtual reality, created on a powerful Silicon Graphics workstation (which provided special effects in *Terminator II* and *Jurassic Park*). An out-of-sight actor wears a Waldo, a plastic helmet with sensors that attach to the actor's cheeks, eyelids, and chin. The sensors pick up facial movements, which cause similar movements on the cartoon's face. A joystick and foot pedal control body movements.

The actor spies on people walking by via a hidden camera and microphone, so the cartoon character appears to be looking directly at passersby and can respond to their comments.

With VActors showing up in stadiums and malls, don't be surprised if the Philly Fanatic, San Diego Chicken, or some other character starts giving you grief.—*Daniel Grotta*


STEPHANIE WAISLER

Sometimes the best way to get to know someone isn't over the phone. But a hot cup of coffee. During a typical day, State Farm agent Dick Dahms talks to a lot of people. It might be on the phone. Or over a cup of coffee at the Ol'e Depot. It's this personal attention that makes Dick such a good neighbor. And such a natural for a State Farm agent. So who better to handle their insurance than Dick? When they stop by his office, he sits down with them, goes over their coverage and helps make sure it's up-to-date. It's called a Family Insurance Checkup. The advice is free – the decision is theirs. State Farm? It's about small towns. And good neighbors who are there for you. Like a good neighbor, State Farm is there.®

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GOODYEAR

THE NEW MICROPROCESSORS

POWER

They're coming to a PC near you. Their performance claims are seductive, but system prices are steep. Should you bite?

BY CHRISTOPHER O'MALLEY

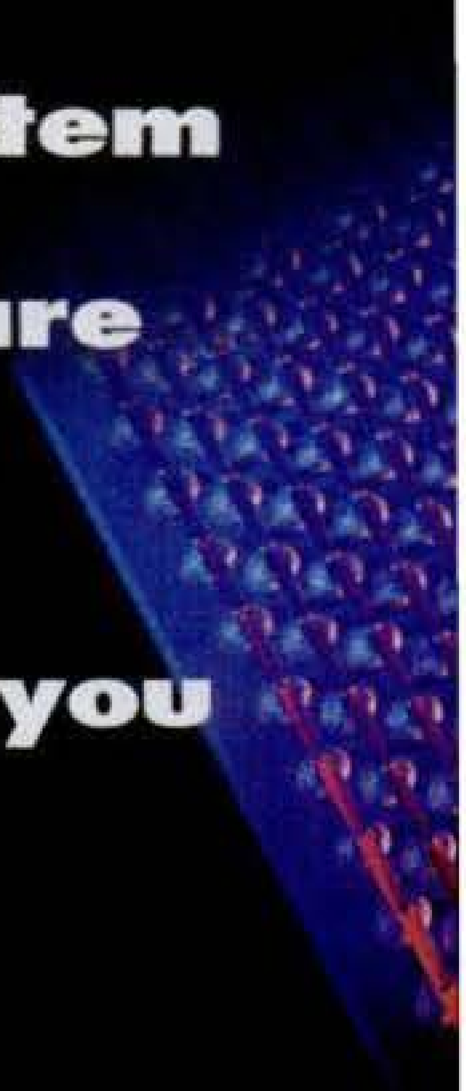
If personal computers were like plumbing, then buying a PC with a more powerful microprocessor would be akin to purchasing a home with a bigger, faster water pump—except your pipes would likely burst from the astounding rise in pressure. The information pumps inside the latest PCs are two to three times faster than today's standard bearers, including the Intel 486 chips installed in IBM-compatible systems and the Motorola 68040 chips inside Apple's Macintosh models.

With a larger water pump, the advantages are simple: You can wash more clothes, take more hot showers, and sprinkle more lawn. With a faster microprocessor (or central processing unit), the benefits come in more sophisticated forms: rapid record sorting, awesome number crunching, zippier chart drawing, and the power to support new ideas for "smarter" software. These new chips go by names like Pentium, Alpha, and PowerPC, and they're out to change the way we use PCs.

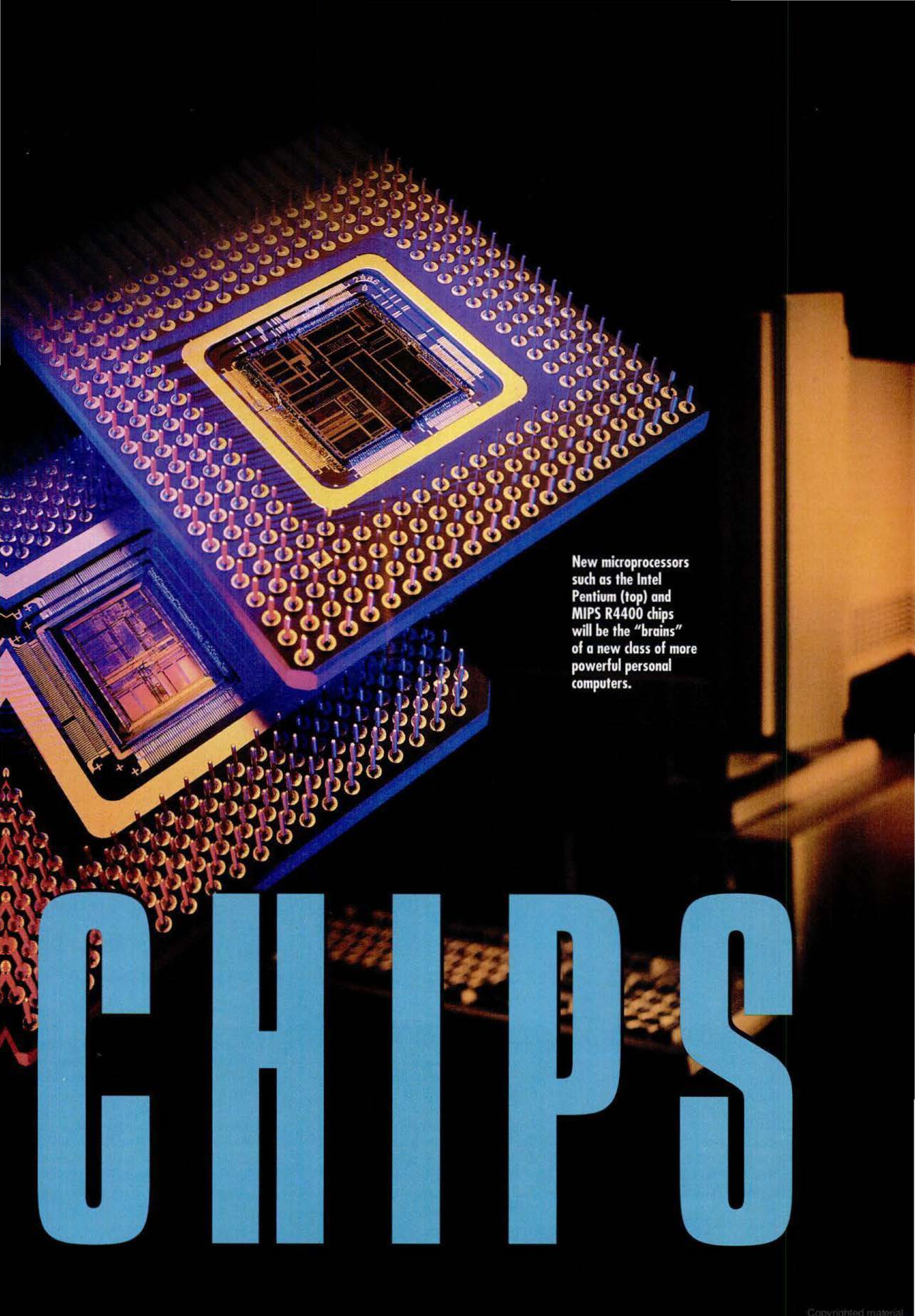
Smaller than a postage stamp, a microprocessor is the central place through which a personal computer controls the ebb and flow of data. There are between 40 million and 60 million computer users in the United States, and many are beginning to wonder whether it's time for a new CPU. The lure of sleek, graphics-based programs running under software "environments" such as Microsoft's Windows and IBM's OS/2 has first-timers and computer veterans alike looking for the more powerful machines needed to run them.

But the already prickly process of picking a PC is getting much more complicated. That's because the defining piece of hardware under the PC's hood, the microprocessor, is undergoing an unprecedented overhaul. And there is no shortage of high-tech mechanics who think they've got just the brain for your next PC. (Complicating the choice of CPUs is an abundance of new operating systems that are due soon. More about them next month.)

Intel's recently released Pentium is leading the parade of new PC processors, but the champion chip maker isn't marching alone this time. No less likely a duo than Apple and IBM has teamed up with Motorola, the chip supplier



PHOTOS BY JOHN B. CARNETT



New microprocessors such as the Intel Pentium (top) and MIPS R4400 chips will be the "brains" of a new class of more powerful personal computers.

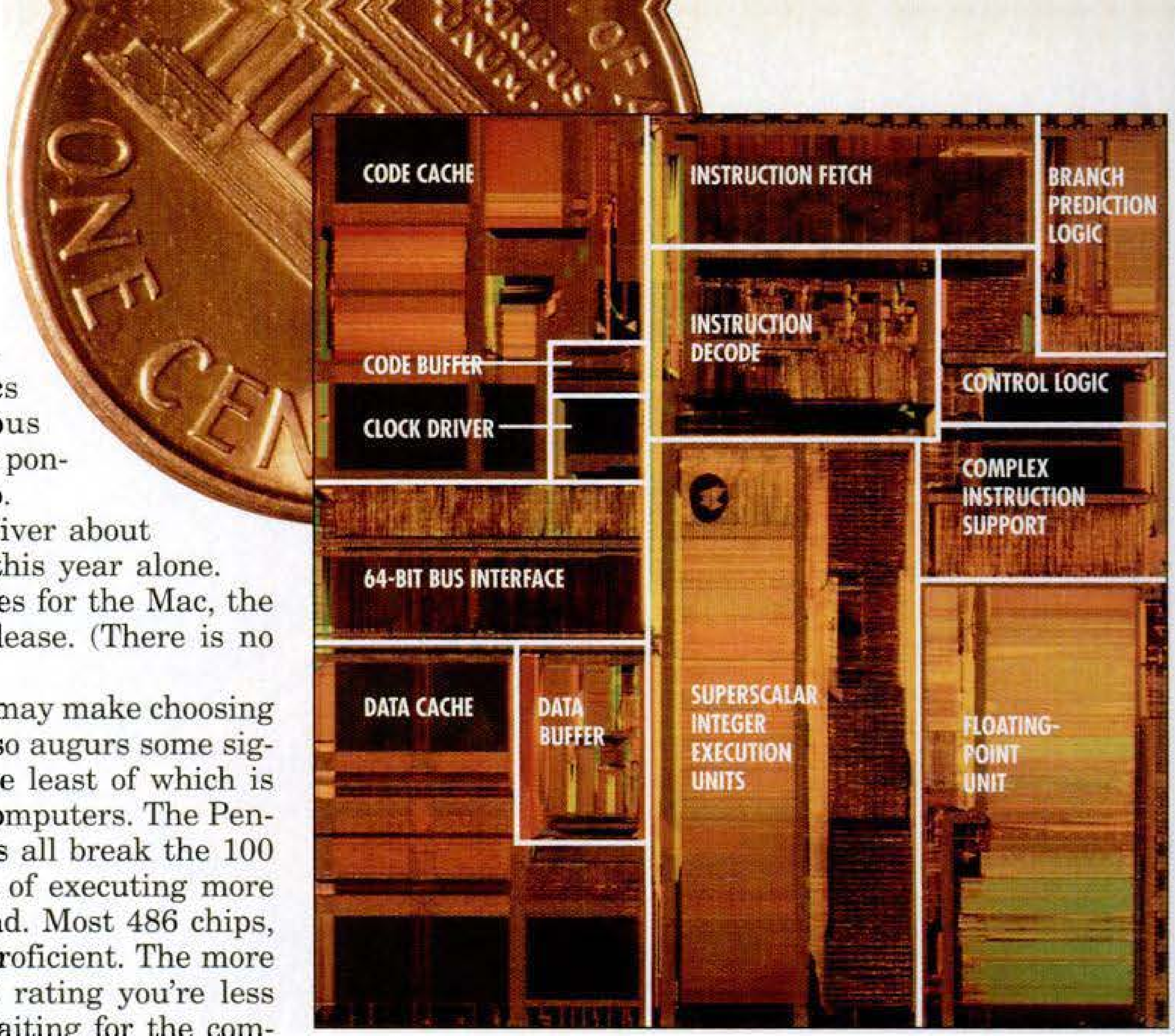
CHIPS

for Macintosh models, to offer an alternative to the Pentium dubbed the PowerPC processor. Digital Equipment Corp. (DEC), best known for its larger computers, is plotting its own push into the PC foundation business with its Alpha processors. MIPS Technologies, a manufacturer of graphics workstations, has similarly ambitious plans. A number of other companies are pondering the plunge into PC processors too.

Intel, meanwhile, has said it will deliver about 35 new variants of its own 486 chips this year alone. And the latest in Motorola's 68000 series for the Mac, the 68060, is scheduled for a mid-1994 release. (There is no 68050.)

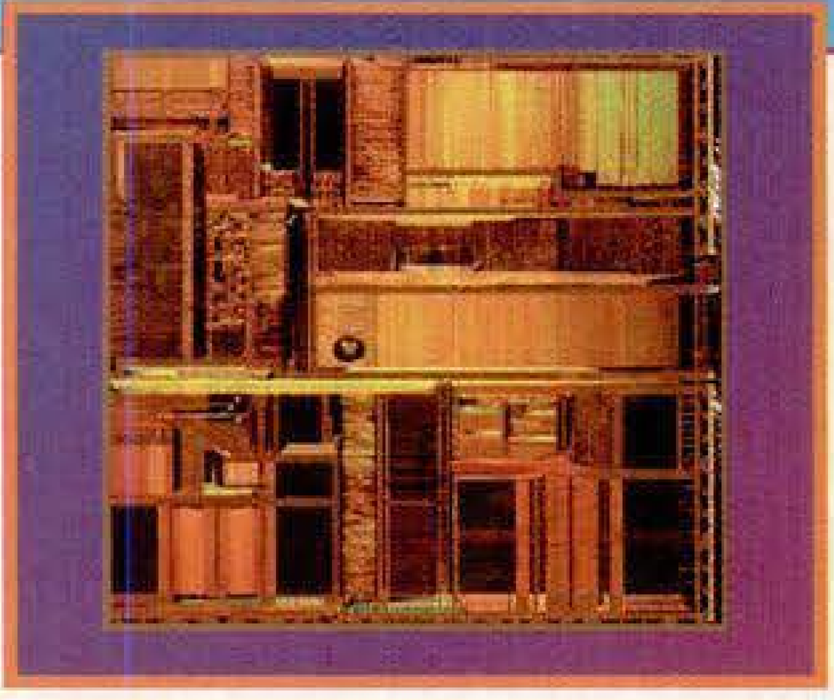
The wealth of microprocessor choices may make choosing a PC that much more difficult, but it also augurs some significant changes for the better—not the least of which is unparalleled performance for desktop computers. The Pentium, PowerPC, Alpha, and MIPS chips all break the 100 mips barrier, meaning each is capable of executing more than 100 million instructions per second. Most 486 chips, by comparison, are not even half that proficient. The more mips, the merrier, since at the higher rating you're less likely to twiddle your thumbs while waiting for the computer to complete a task.

The added horsepower will make chores such as budget building and accounting run much faster, and speed up graphical interfaces such as Windows and the Macintosh's System 7. More important in the long run, these new chips will give computer builders and software publishers the kind of processing power they need to infuse PCs with a host of "multimedia" qualities, including photo-realistic images, full-motion video, and CD-quality audio. More electronic brainpower could also give PCs the "intelligence" to tackle



HOW DOES SOMETHING SO SMALL DO SO MUCH? **At 16 millimeters (or about six-tenths of an inch) square, Intel's Pentium chip is considered a little large by today's PC standards. But Pentium is also one of the most complex and densely packed processors ever designed, with 3.1 million tiny transisitors etched onto its silicon wafer. The circuitry is organized into functional compartments, as this photo shows.**

HOW THE NEW MICROPROCESSORS STACK UP



PENTIUM

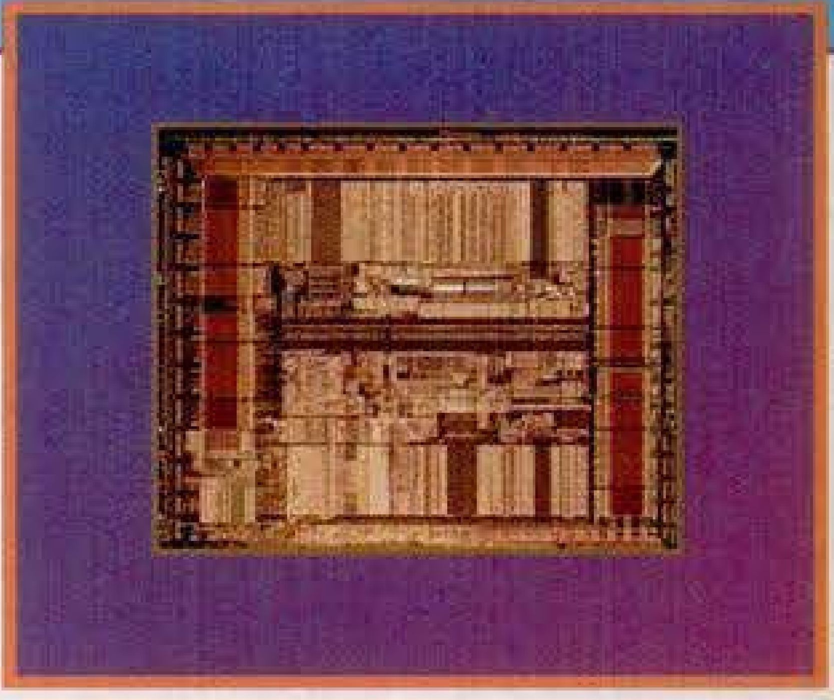
- Intel's new 32-bit chip is at the heart of a new generation of PCs that run DOS, Windows, OS/2, and Unix programs. AST, Compaq, Dell, IBM, and NEC are among the many computer makers who say they will offer Pentium-based PCs this year. Prices range from $4,000 to $8,000.

- Pentium is more than two times faster than the best 486 chip, Intel's 486DX2-66, despite running at a similar clock speed (66MHz). Much of the credit for the performance boost goes to its superscalar design, which enables the chip to compute two instructions at a time.

POWERPC 601

- Apple, IBM, and Motorola have teamed up to produce this 32-bit chip that will be used in future Apple Macintoshes and IBM PCs. PowerPC systems will run Mac or Unix programs, and possibly Windows software in the future. Prices will start at $2,000 to $3,000.

- Initially, PowerPC comes in two speeds: 50MHz and 66MHz. The latter version runs at about the same pace as Intel's Pentium chip, and employs a similar superscalar feature. The PowerPC uses a more modern reduced-instruction-set (RISC) design, however.



ALPHA 21064

- Digital Equipment Corp.'s 64-bit Alpha processor is already being used in larger computers, and will soon make its way into PCs from Digital, Olivetti, and others. Alpha systems will run Windows or Unix programs, and are expected to cost $3,000 to $5,000.

- Alpha offers performance that is a cut above the first Pentium and PowerPC chips. Alpha uses a RISC architecture and has fewer transistors than the other new chips, but it runs at higher clock speeds: 150 and 200MHz. It also has a superscalar feature.

tasks such as speech and handwriting recognition, as well as the capacity for more sophisticated communication tasks.

The increased competition among chip makers should accelerate the onset of these innovations even beyond the normally feverish pace of change in the PC world. And, the price of progress should keep right on dropping. Costing as much as 25 percent of the average system price, the microprocessor is typically the most expensive part in a PC, and the intensifying rivalry among microprocessor suppliers has prompted a price war of sorts even before many of the chips are available. DEC recently slashed the wholesale price of its least expensive Alpha chip, which hasn't yet appeared in PCs, from $1,350 to $850, for example. PowerPC chips will sell for less than $400 in volume.

The new microprocessors could bring an unaccustomed sense of decorum to the computing landscape too. Pentium chips, for instance, will be used not only in PCs but also in mid-size and huge mainframe computers, extending the prospect of using the same software on all machines. Even the gulf between PCs and Macs may someday be bridged. Both IBM and Apple plan to use PowerPC chips in upcoming desktops, as well as in "server" systems that manage networks of PCs.

But for the foreseeable future, at least, you will be confronted with a more chaotic set of choices. And which microprocessor sits inside your next PC matters a great deal. It will affect the price you pay, the performance you get and, most critically, the type of software you can run—now and for years to come.

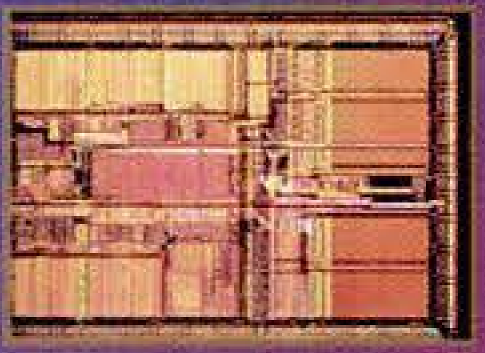
By most reckonings, PCs built around Intel's Pentium chip are not likely to be the cheapest or the fastest of the new generation. They will, however, be the most versatile in terms of the range and number of programs they can run. Though Intel chose not to adopt the "586" tag (for trademark reasons), that's essentially what Pentium is: a successor to the 8086, 286, 386, and 486 chips that came before it. Hence, it runs all of the software written for the MS-DOS, Windows, and OS/2 operating systems.

The first versions of the Pentium are only a starting point for this new-generation chip. Intel has future improvements planned that will be the basis for even faster and less power-hungry PCs.

The Pentium (the name derives from "fifth element") is a remarkably intricate processor, squeezing 3.1 million microscopic transistors—nearly three times the number on a 486 chip—onto a sliver of etched silicon. Much of that enormous overhead stems from the Complex Instruction Set Computer, or CISC, design that's needed for the chip to remain compatible with the thousands of programs written for all those "x86" machines. While some chip makers can cut corners with more efficient Reduced Instruction Set Computer, or RISC, designs, Intel carries the baggage of chips that are now more than a dozen years old.

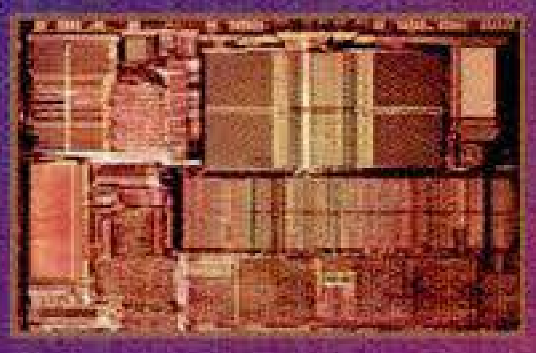
Don't underestimate the power of compatibility. It's the Pentium's biggest selling point. If you can continue using the programs you already know and the files you already have, the transition to a new machine is much simpler. Intel has managed to mingle compatibility with state-of-the-art performance in the Pentium. Although the first two versions of the Pentium run at speeds similar to the fastest 486 chips (60 megahertz and 66 megahertz), they move both software instructions and data at much quicker rates (see Pentium: See How it Runs). Unlike previous Intel chips, the Pentium has dual pipelines that enable it to process two separate instructions in a single cycle, a design known as superscalar. Pentium also sends and receives data in 64-bit chunks rather than 32 bits at a time, though the internal computing is still done in 32-bit parcels, as it is with 386 and 486 chips.

To expedite things even more, Intel gave the Pentium chip a "branch prediction" feature that actually attempts to



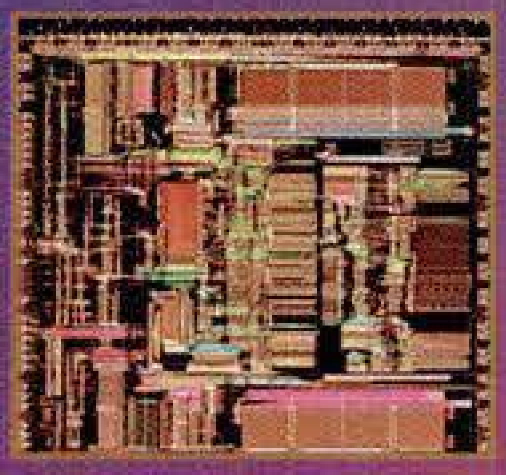
R4400

- The 64-bit R4400 and slower R4000 chips from MIPS Technologies are being manufactured by six companies and should appear in a wide variety of PCs, including one early model from Acer. These PCs will run Windows or Unix programs, and cost $2,000 to $5,000.
- The R4400 is a RISC-design processor that comes in 100, 134, and 150MHz versions. At its top speed, the R4400 is one of the fastest PC processors ever produced, outpacing even the 150MHz Alpha chip. Like the Pentium, PowerPC, and Alpha, it is a superscalar chip.



486

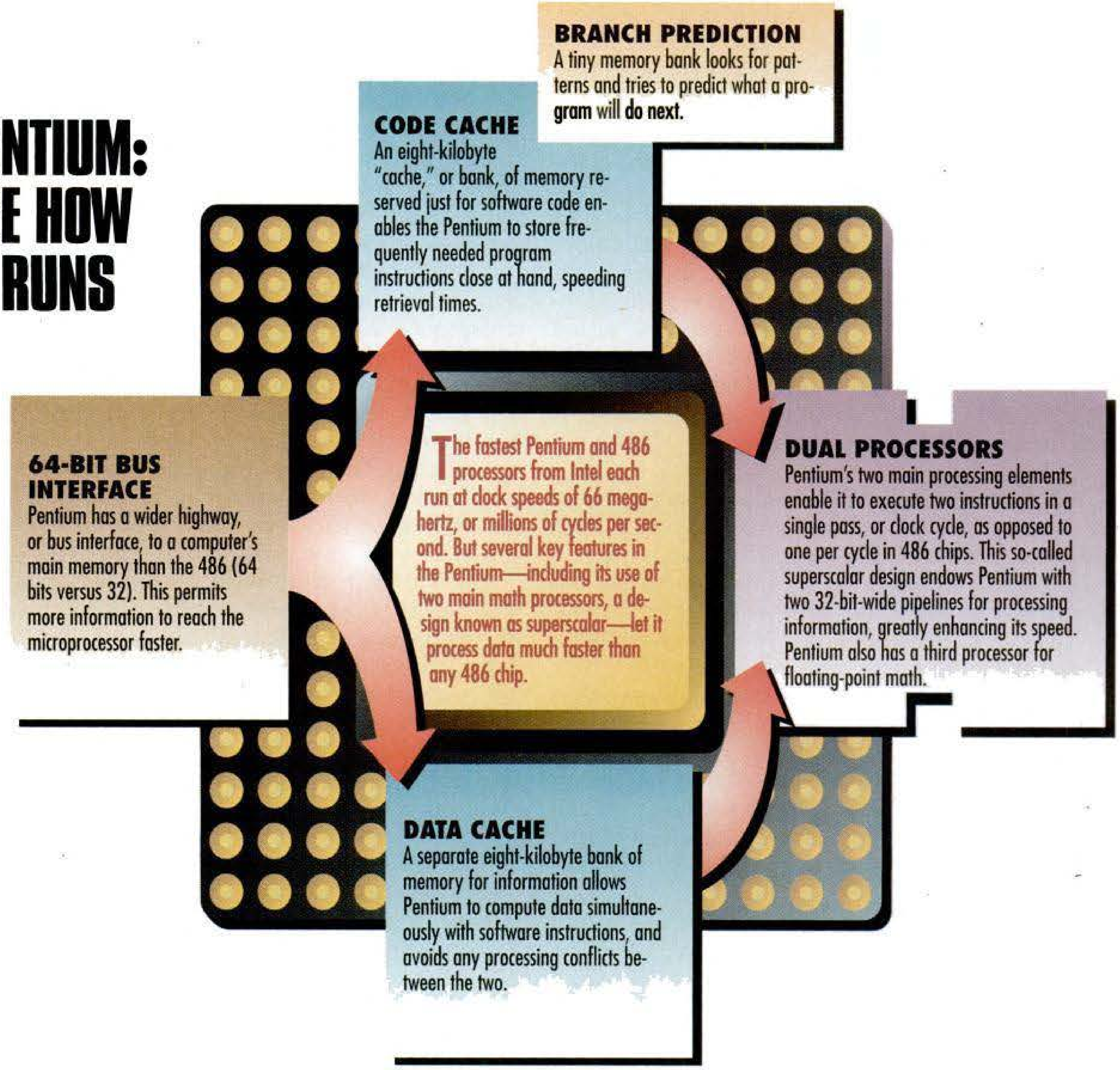
- Intel's 32-bit 486 chips are the "brains" inside the majority of IBM-compatible PCs sold today. These PCs run DOS, Windows, OS/2, and Unix programs, and are made by every major PC company except Apple. Prices typically range from $1,500 to $3,000, depending on speed.
- The 486 chip now comes in many varieties. Among the most popular are the 486SX running at 25MHz, the 486DX running at 33MHz, and the 486DX2 running at 66MHz. New 486 chips work at lower voltages to save electricity, and still faster (perhaps 100MHz) versions are coming.



68040

- Motorola's 32-bit 68040 microprocessor is the engine powering Apple's fastest Macintosh systems, including Centris and Quadra models. These computers run graphics-based software written especially for the Mac, and cost between $2,700 and $6,000.
- The 68040 is in the same performance league as the 486, but the 68040 is only available in 25, 33 and 40MHz versions. Its successor, the forthcoming 68060, will run at 50MHz and 66MHz speeds, feature a superscalar design, and use less electricity.

PENTIUM: SEE HOW IT RUNS



BRANCH PREDICTION
A tiny memory bank looks for patterns and tries to predict what a program will do next.

CODE CACHE
An eight-kilobyte "cache," or bank, of memory reserved just for software code enables the Pentium to store frequently needed program instructions close at hand, speeding retrieval times.

64-BIT BUS INTERFACE
Pentium has a wider highway, or bus interface, to a computer's main memory than the 486 (64 bits versus 32). This permits more information to reach the microprocessor faster.

The fastest Pentium and 486 processors from Intel each run at clock speeds of 66 megahertz, or millions of cycles per second. But several key features in the Pentium—including its use of two main math processors, a design known as superscalar—let it process data much faster than any 486 chip.

DUAL PROCESSORS
Pentium's two main processing elements enable it to execute two instructions in a single pass, or clock cycle, as opposed to one per cycle in 486 chips. This so-called superscalar design endows Pentium with two 32-bit-wide pipelines for processing information, greatly enhancing its speed. Pentium also has a third processor for floating-point math.

DATA CACHE
A separate eight-kilobyte bank of memory for information allows Pentium to compute data simultaneously with software instructions, and avoids any processing conflicts between the two.

TOM WHITE

predict what a software program is likely to do next, and then "fetches" the required instructions from memory—a technique that can improve performance by up to 25 percent. Pentium has two separate cache, or temporary, memory banks, one for storing repetitive instructions and another for data (see Caching in the Chips). Like the 486, Pentium also has a built-in floating-point unit, or math coprocessor, that can greatly accelerate the rendering of complex graphics or statistical computations.

The net result, according to Intel estimates, is that the Pentium runs three to five times faster than a 486DX processor at 33 megahertz, or more than twice as fast as a "clock-doubled" 486DX2 chip at 66 megahertz. While the Pentium will run all DOS and Windows software, many programs will need to be "recompiled," or retuned, for the Pentium chip in order to achieve those kinds of gains. Microsoft, Lotus, Borland, and other major publishers have all pledged to optimize their programs for the Pentium in future releases.

As with any microprocessor, the level of performance that the Pentium brings is dependent on the components that surround it. Many of the biggest names in desktop computers, including IBM, Compaq, and Dell, have already designed entire systems around the Pentium processor. The first wave of Pentium-based PCs, available in limited quantities this summer, is expected to cost between $4,000 and $8,000.

Is a Pentium PC worth that kind of money? Probably not to most people. The prices of Pentium-based systems will begin dropping almost as soon as they hit the streets, of course, but it may be well into 1994 or even 1995 before Intel delivers the quantities needed to make Pentium models affordable to all. In the meantime, complete 486SX systems (with ample memory and hard disk space, with a color display) sell for as little as $1,500. Even the fastest 486DX2 computers go for less than $3,000. That makes the 486 "a better bargain for the vast majority of PC users," says Michael Slater, editor of the *Microprocessor Report*, an industry newsletter.

Indeed, low-cost 486 computers have proven so affordable lately that desktop PCs based on Intel's eight-year-old 386 chip are an endangered species. Most companies sell only one 386 desktop model, if they sell any at all. (Many portable PCs still use 386 chips, however.) And new 286 systems are virtually nonexistent.

The 486 generation is in no such danger. Intel, Advanced Micro Devices (AMD), and Cyrix Corp. are each unleashing a series of new 486 chips this year. Many of these will be electricity-saving processors that run at 3.3 volts instead of the usual five volts. That change, coupled with built-in power-managing features, should extend the battery life of laptop PCs and save energy with desktop models. Higher-speed versions of the 486 are in the works as well. Later this year, Intel is expected to introduce a "clock-tripled" chip called the 486DX3, running at 100 megahertz. Intel may also add Pentium-like features to its 486 chips, such as superscalar processing and more cache memory. That won't close the performance gap between 486 and Pentium chips, but it could narrow it considerably.

Intel is also providing a hedge against long-term obsolescence. Most of the PCs engineered around its 486DX2 chips have special upgrade sockets, called OverDrive sockets, that will accommodate a plug-in version of the Pentium chip, which is due sometime next year.

Cyrix and AMD will deliver new 486 chips this summer that are entirely compatible with Intel's 486SX and 486DX chips—the first such competition in the 486 field (though several 386-compatible chips are available). AMD and Cyrix also say they will introduce Pentium-class "586" chips, running all of the same software as the Pentium in 1994.

The more immediate, and perhaps more estimable, alternative to the Pentium for computer buyers comes from the ranks of RISC chip makers. The PowerPC effort directed by IBM, Apple, and Motorola is the most ambitious project, attempting to fundamentally alter the status quo in both the PCs and Macs of the desktop world.

The PowerPC 601 is a new processor, but not one without a past. It's based on the same RISC microprocessor used in IBM's RS/6000 series of scientific workstations and network servers and has the potential to run some of the software used by those larger systems. But both IBM and Apple envision the PowerPC as a mainstream alternative to the Pentium and the other Intel and Motorola chips that have driven PCs for more than a decade. IBM plans to debut its first PowerPC desktop by the end of the year, and Apple is expected to introduce the first PowerPC-based Macintosh shortly thereafter—possibly in January to mark the Mac's tenth anniversary.

Technically, the PowerPC chip, despite its RISC architecture, has much in common with Pentium. It's a tightly packaged 32-bit microprocessor with many of the same features: superscalar design, branch prediction, large cache memory, and an integrated floating-point processor. Initially available in 50 megahertz and 66 megahertz versions, the PowerPC 601 should be comparable to the Pentium's performance. There are already two faster versions, the 604 and 620, slated for 1994.

The PowerPC's principal drawback is that it's *not* compatible with current DOS, Windows, or Macintosh software—at least not innately. A new software environment called PowerOpen will enable most Mac programs to run in an "emulation" mode, but Mac software won't be able to take full advantage of the PowerPC's speed until Apple's System 7

[Continued on page 88]

CACHING IN THE CHIPS

TIM McGARVEY

The ever-increasing speeds of today's microprocessors serve to highlight one of the principal bottlenecks in modern PCs: getting software instructions and data from the system's relatively slow memory chips to its fleet-footed processor. So-called cache memory, a specialized form of random-access memory (RAM) that acts as an electronic way station for frequently needed information, is accelerating the delivery process, however.

If RAM is the short-term memory of a computer (as opposed to the long-term memory of disk storage), then a RAM cache is a computer's *selective* memory. A bank of cache memory remembers only the most commonly requested bits of software code and data. When the microprocessor initially requests a portion of program code or data stored in memory, it's retrieved from main memory—which delivers it at a far slower rate than the microprocessor could handle. A RAM cache, which typically uses faster chips than main memory, keeps a copy of the transaction. Subsequent requests for the same information can then be retrieved directly from the cache without resorting to main memory.

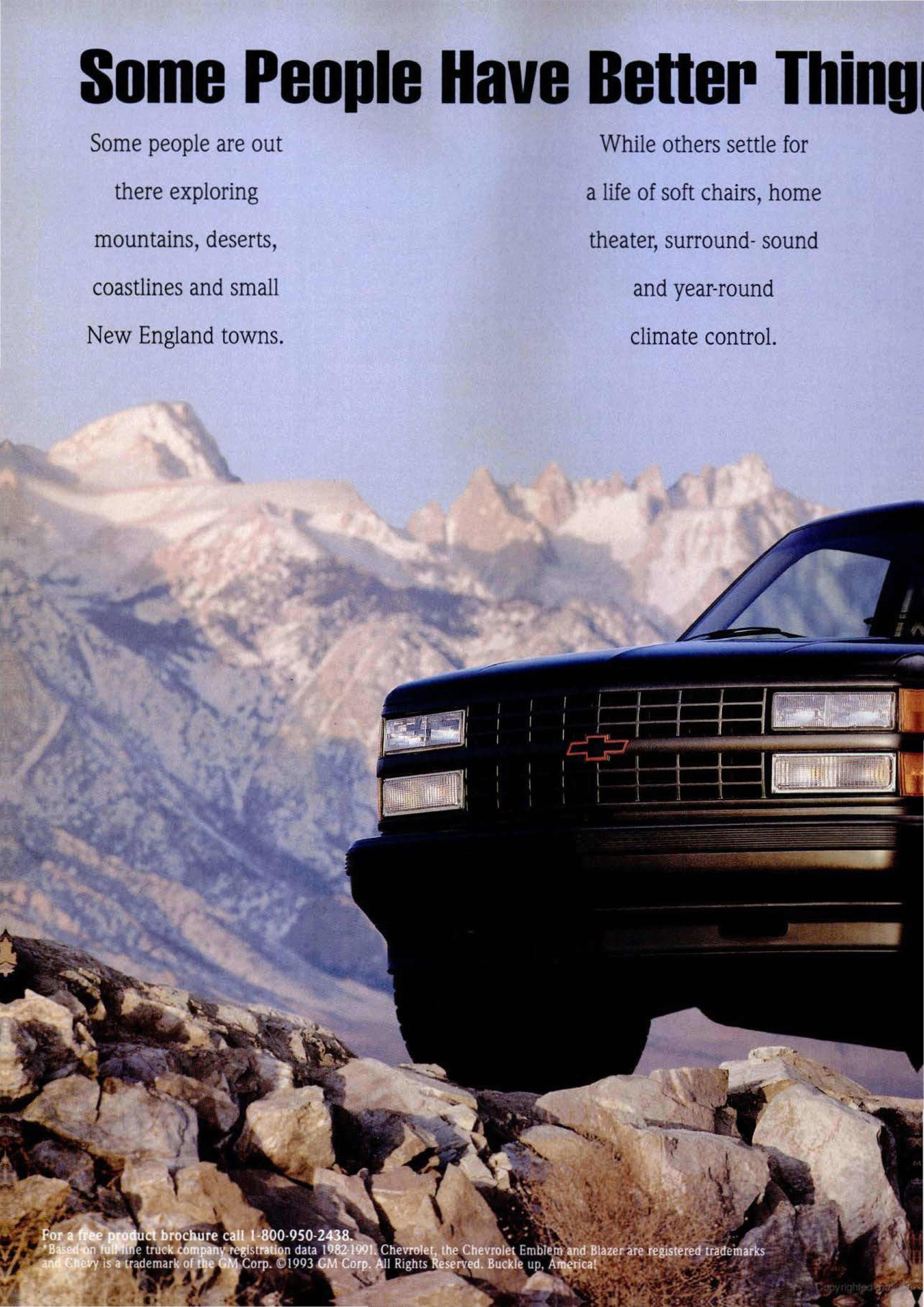
How much caching improves a system's performance depends on a number of factors, including the size of the cache, the type of memory chips being used, and the software you're running. But gains of 20 to more than 100 percent (compared with non-cached speeds) are not unusual.

Caching has become such a vital technique, in fact, that all of today's newer microprocessors have memory caches built right into their silicon designs. Intel's 486 chips each have an eight-kilobyte cache, and its new Pentium processor sports dual eight-kilobyte caches—one for software code and one for data. Digital Equipment's Alpha chip uses the same dual eight-kilobyte caching arrangement. The PowerPC processor designed by IBM and Motorola doubles that again with 32 kilobytes of cache memory. In general, the more cache built into a microprocessor, the bigger boost you will see in real-world performance. But how the cache is organized, and how it decides what to keep and what to throw back to main memory can skew the numbers.

External, or "secondary," memory caches are becoming popular too. Many system designers now leave room on their main circuit boards (or motherboards) to add memory that can be used to complement the cache integrated into the microprocessor. Secondary memory caches are also available as plug-in cards, and many companies now add caches to their video and disk controller boards to speed their performance on specific tasks.

In a sense, caches address the symptoms of slower memory speed, not the problem itself. Memory chips are gradually getting faster, and research into new memory technologies is as "dynamic" as the chips comprising a PC's main memory. But given the incredible pace of microprocessor advances, the need to carry cache isn't likely to diminish anytime soon.—*C. O.*

Compaq's new Deskpro 5/66M is one of the first PCs to use Intel's Pentium chip.



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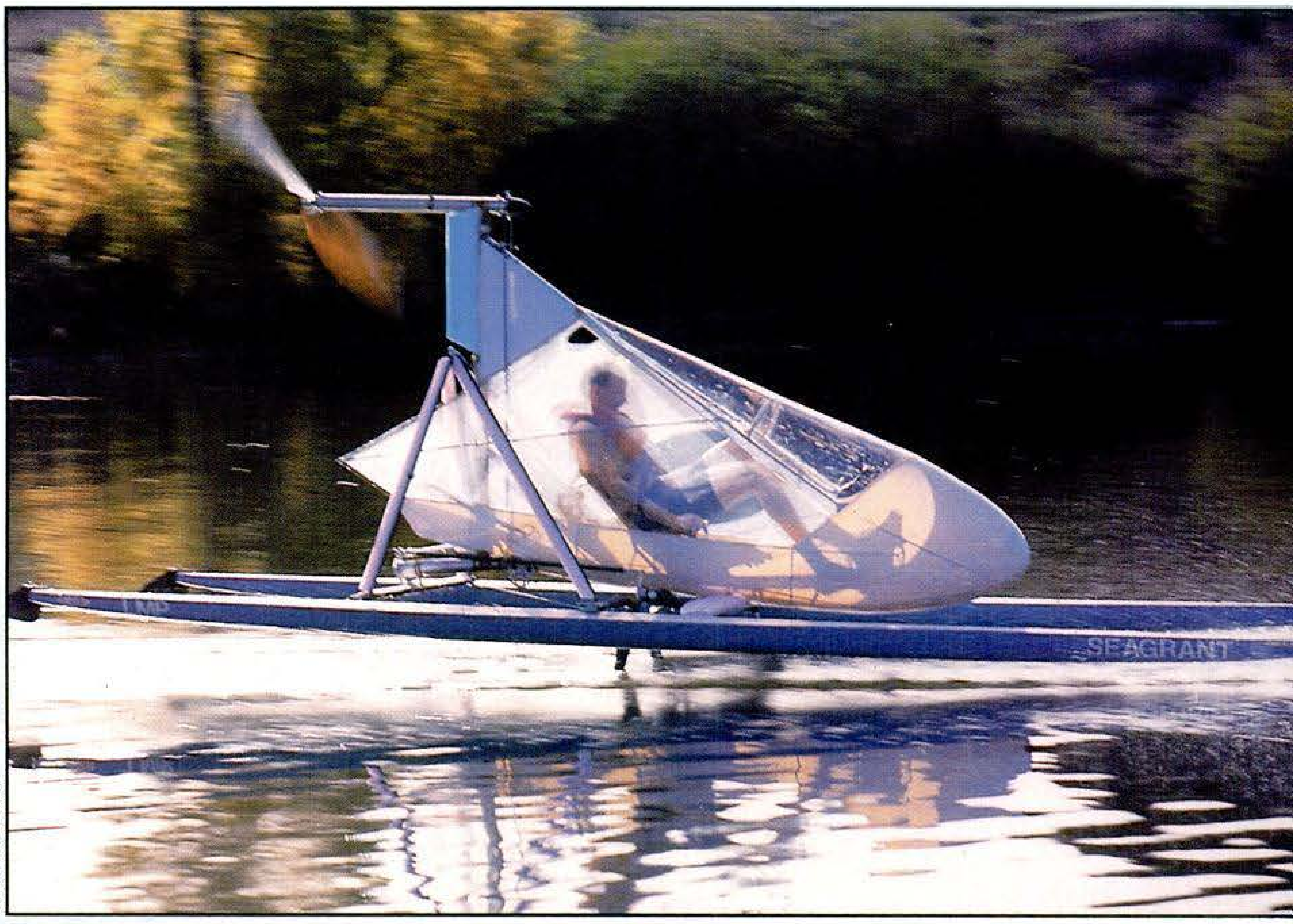

STUART F. BROWN

The race for the fastest human-powered watercraft has a winner.

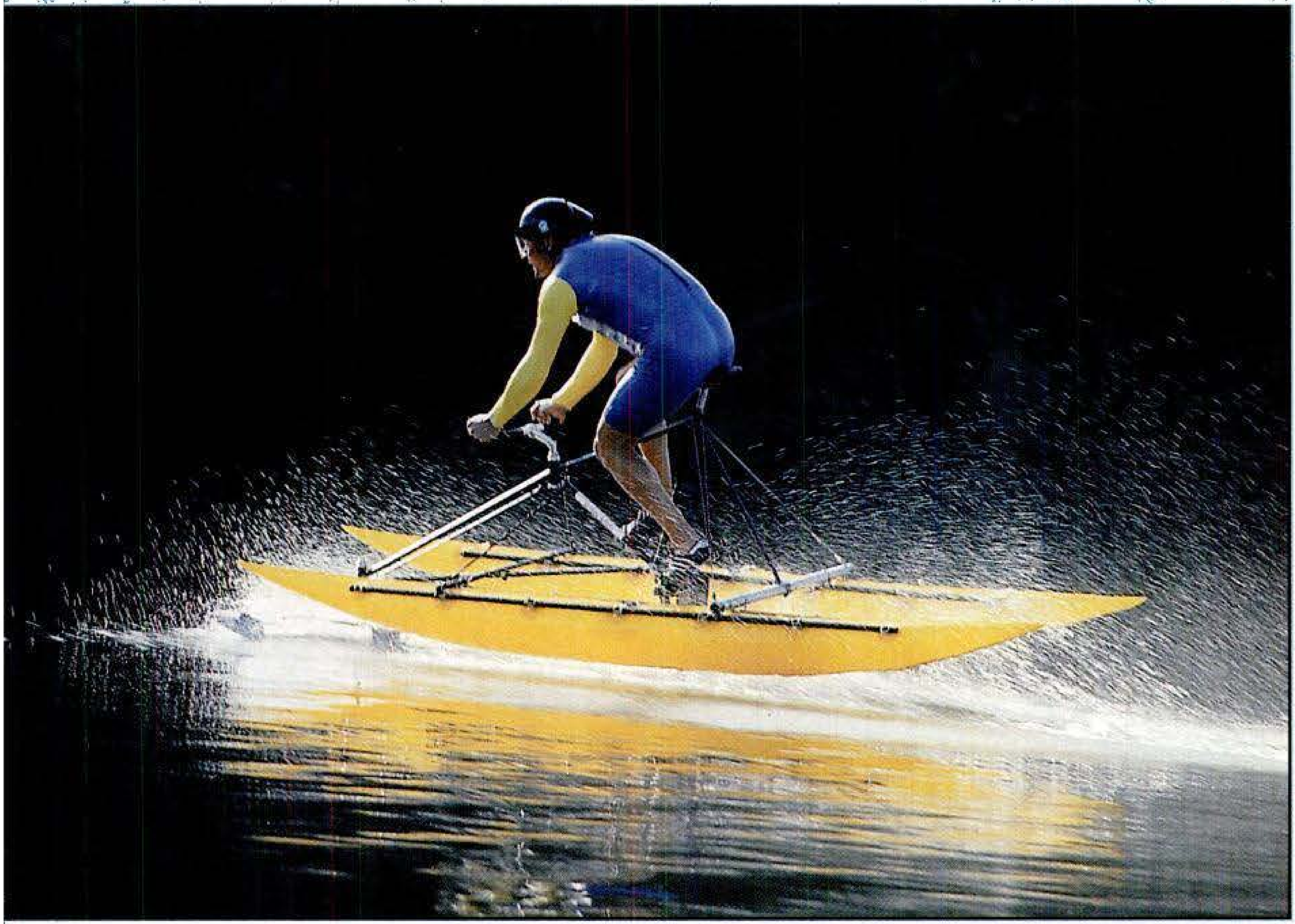
BY STUART F. BROWN

Decavitator skims across Puddingstone Reservoir in San Dimas, Calif. The 48-pound watercraft didn't manage to better its fastest run on this attempt.

How fast can a watercraft sprint for 100 meters with one person as its power source? Competitors refined their designs, ran through the timing clocks, tweaked and tried again, fiddled, then ran some more during the past three years in pursuit of the $25,000 Du Pont Speed Prize. The quest was hitting a brisk 20 knots (23 mph), a velocity calculated to be attainable—in theory, at least. But it was a stretch, and nobody was sure they could actually get there.

When the contest expired on the last day of 1992, a craft called *Decavitator* hadn't quite hit the magic number, but had posted the highest certified speed of 18.5 knots (21.28 mph), fast enough to claim the cash. Constructed by a team from the Massachusetts Institute of Technology (MIT) in Cambridge, *Decavitator* uses a slow-spinning air propeller

FLYING FISH


STEVE FINBERG

Looking like a bicycle atop slender bananalike pontoons, the 40-pound *Flying Fish 20* is up on its wings with a bicycle racer furnishing the propulsion.

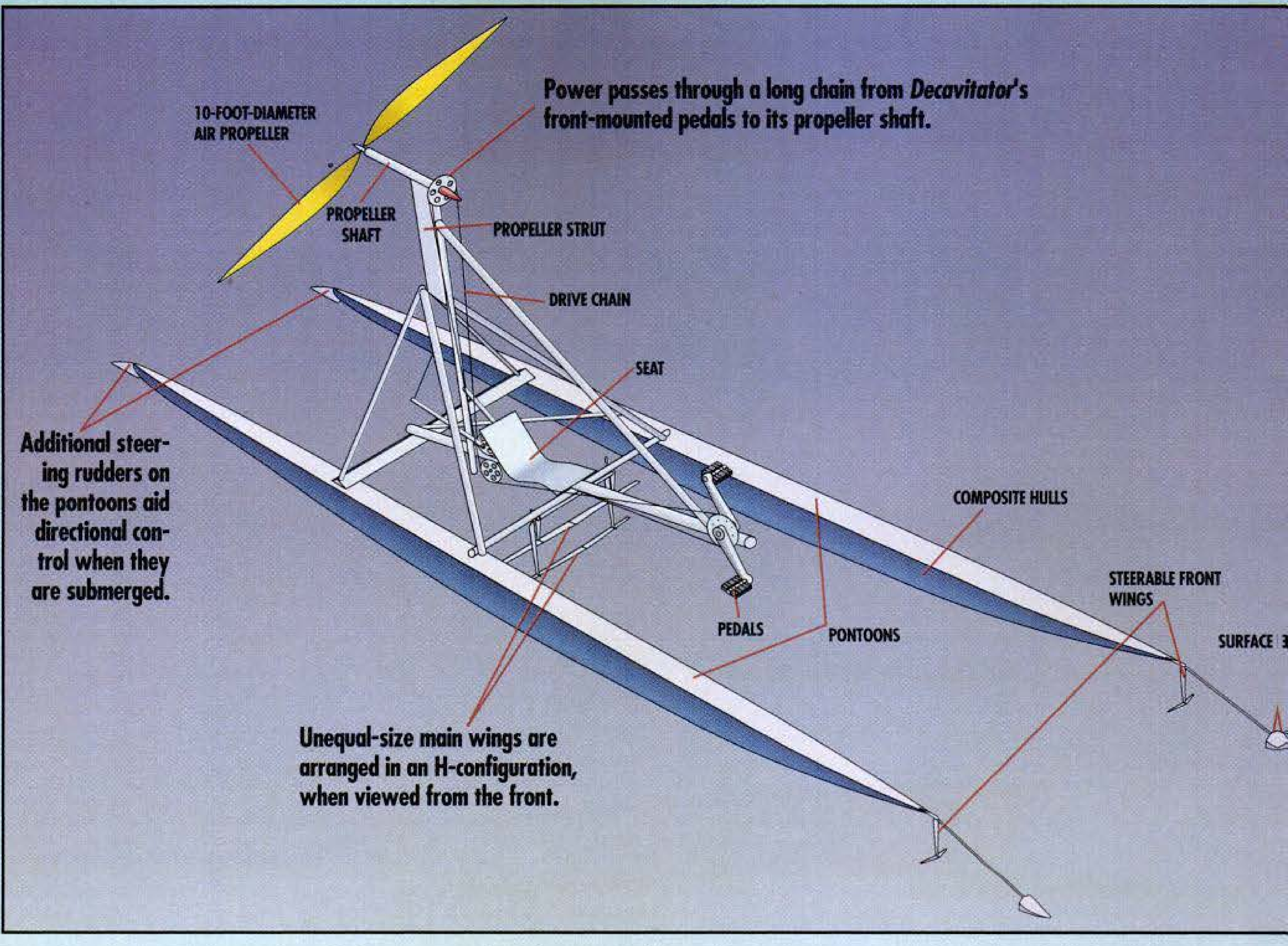
to push it through the water like an Everglades airboat. The boat's builders are led by Mark Drela, an MIT aeronautics and astronautics professor who was the aerodynamicist for the *Daedalus* human-powered aircraft flight from Crete to Greece ["88-Pound Pedal Plane," Feb. '87].

Since the prize competition was organized in 1989 by the Indianapolis-based International Human-Powered Vehicle Association (IHPVA), the MIT boat had dueled with *Flying Fish 20*, a quite-different-looking craft that reached a best official speed of 16.7 knots (19.21 mph) using a submerged propeller. *Flying Fish* is the creation of Alec Brooks and Allan Abbott. Brooks directs the electromechanical group at AeroVironment Inc. in Monrovia, Calif., where he was chief engineer on General Motors' solar-electric Sunraycer car and the prototype Impact electric passenger car. Abbott is a physician and professor at the University of Southern California who has set speed records in human-powered land vehicles.

A look at the two speedsters shows how different inventors can come up with widely varying solutions to the same challenge, though the craft share several features: Rotating pedals drive propellers through chains and sprockets. Twin floats provide buoyancy at low speeds, and hydrofoils—or underwater wings—lift the floats out of the water at higher speeds, slashing hydrodynamic drag by greatly reducing wetted area. But beyond this, differences in design philosophy abound.

Decavitator is built to keep itself almost entirely out of the water, which, at 850 times the density of air, imposes a vastly greater drag penalty. Thus the boat can be powered by a spindly 140-pound rider: Drela himself, who has been tagged with the water-flying handle "toothpick." The MIT craft uses smooth composite flotation hulls modeled after a racing kayak. A pair of unequally sized foils helps the boat accelerate and climb out of the water with moderate de-

A BIG PROPELLER IN THE AIR


10-FOOT-DIAMETER AIR PROPELLER
Power passes through a long chain from *Decavitator*'s front-mounted pedals to its propeller shaft.
PROPELLER SHAFT
PROPELLER STRUT
DRIVE CHAIN
SEAT
Additional steering rudders on the pontoons aid directional control when they are submerged.
COMPOSITE HULLS
STEERABLE FRONT WINGS
SURFACE
PEDALS
PONTOONS
Unequal-size main wings are arranged in an H-configuration, when viewed from the front.

ILLUSTRATIONS BY STEVE STANKIEWICZ

mands on the energy reserves of the rider, who pedals in a recumbent position.

From a standstill to a speed of about eight knots, *Decavitator* runs with its hulls submerged. At greater speeds, the boat begins to rise onto its foils. When the speed reaches about 14 knots, the rider pulls a lever to increase the foils' angle of attack. As the larger upper foil rises out of the water, it flips forward into a streamlined storage pod. The resulting reduction in water drag increases the boat's speed by approximately three knots with about the same amount of pedaling effort. Now the craft is supported by the small high-speed water wing, which carries it to its maximum speed.

Spinning at 250 rpm, the ten-foot-diameter propeller is designed for best efficiency at *Decavitator*'s intended top speed of 20 knots. At lower speeds, its efficiency drops off considerably. The MIT designers chose the fairly complex dual-foil system for its small, high-lift wing area and relatively low-power requirement at medium speeds. Sprinting to high speed takes much more rider effort, but brings the propeller closer to its design speed where drag losses are lowest.

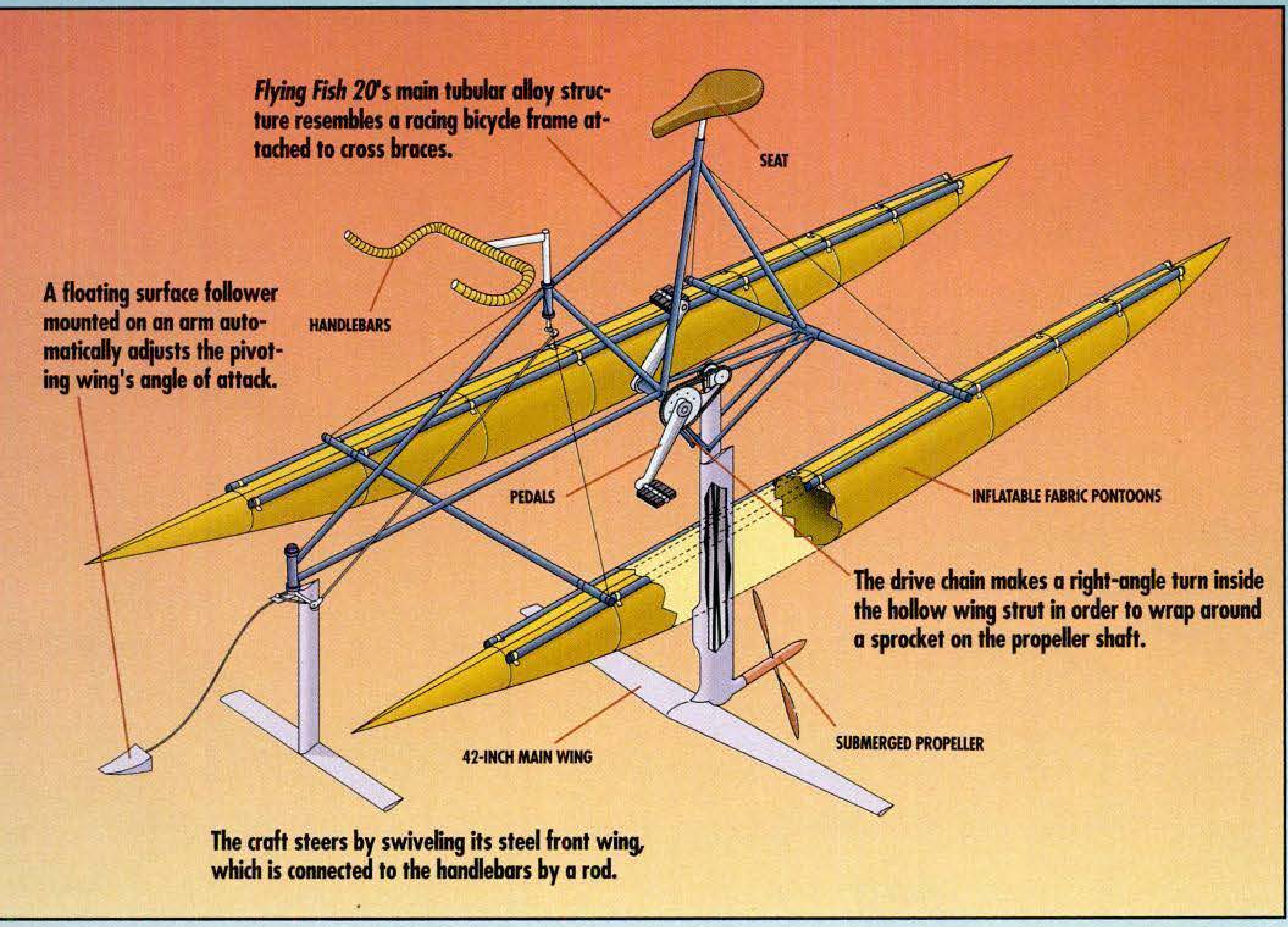
Perhaps most important, the big air propeller lets *Decavitator* capitalize on the 3.2-knot maximum tail wind that the IHPVA permits during official speed runs. The rules require only a one-way pass through the timing traps, so running in front of a legal breeze is the strategy of choice. It's possible that the official speeds of the two craft would have been closer if they had made all of their timed runs side-by-side under the same wind conditions, or running both with and against the wind, but that's not what the rule book stipulates.

Flying Fish 20 represents a contrasting idea about how to go fast on water. "We went for the brute-force, high-drag, high-horsepower approach," says Brooks, citing the advantages of mechanical simplicity. Using a conventional bicycle riding position with no controls except steering lets the team recruit powerful cycle racers who feel at ease aboard the watercraft after a little practice. Inflatable fabric pontoons support the *Fish* until it climbs onto its foils.

The designers' decision to use a single main foil dictated a compromise of shape with greater surface area than multiple wings would have. And the need to enclose the chain driving the small water propeller requires a large, submerged vertical strut. Together, these components account for most of the higher water drag in the *Flying Fish* layout.

Flying Fish 20 is the third incarnation of a 1984 craft that was originally designed to be catapulted from a floating ramp, thereby entering the water at takeoff speed without the need for pontoons. Olympic cyclist Steve Hegg pedaled *Flying Fish I* to a world's record 2,000-meter run this way,

A SMALL PROPELLER IN THE WATER



Flying Fish 20's main tubular alloy structure resembles a racing bicycle frame attached to cross braces.

A floating surface follower mounted on an arm automatically adjusts the pivoting wing's angle of attack.

The drive chain makes a right-angle turn inside the hollow wing strut in order to wrap around a sprocket on the propeller shaft.

The craft steers by swiveling its steel front wing, which is connected to the handlebars by a rod.

beating by ten seconds the time set by a single-rower racing shell. The *Flying Fish II* version, built in 1986, received a set of pontoons, equipping it for standing-start events.

The builders had to overcome several problems in sorting out *Flying Fish 20*—named after its hoped-for maximum speed—for the 100-meter Du Pont prize attempts. Persistent bending of the inverted T-shaped carbon-fiber main foil led to its replacement with one cast from hand-polished chrome-moly steel alloy. Reinforcing layers of carbon fiber were added to the supporting strut to cure a twisting movement that prevented the craft from climbing onto its wings. Finally, adding a small ledge to the strut's trailing edge solved an intermittent problem with air being drawn down from the water's surface, spoiling the propeller's thrust.

Decavitator and *Flying Fish 20* both borrow an idea for their small front foils from one of the grand old men of human-powered hydrofoil experimentation, engineer Sid Shutt of Brea, Calif., whose *Hydroped II* established a speed record of 13.8 knots in 1988. Shutt worked out the mechanics of running a spade-tipped surface-following arm in front of a pivoting foil. Roughness on the water's surface automatically adjusts the foil to an optimal angle of attack. Greg Ketterman, designer of Trifoiler ["World's Fastest Sailboat," Jan. '91], was also inspired by Shutt's simple and effective solution to the problem of pitch control. PS

HUMAN-POWERED SPEED PRIZES: SPARK PLUGS FOR INVENTION

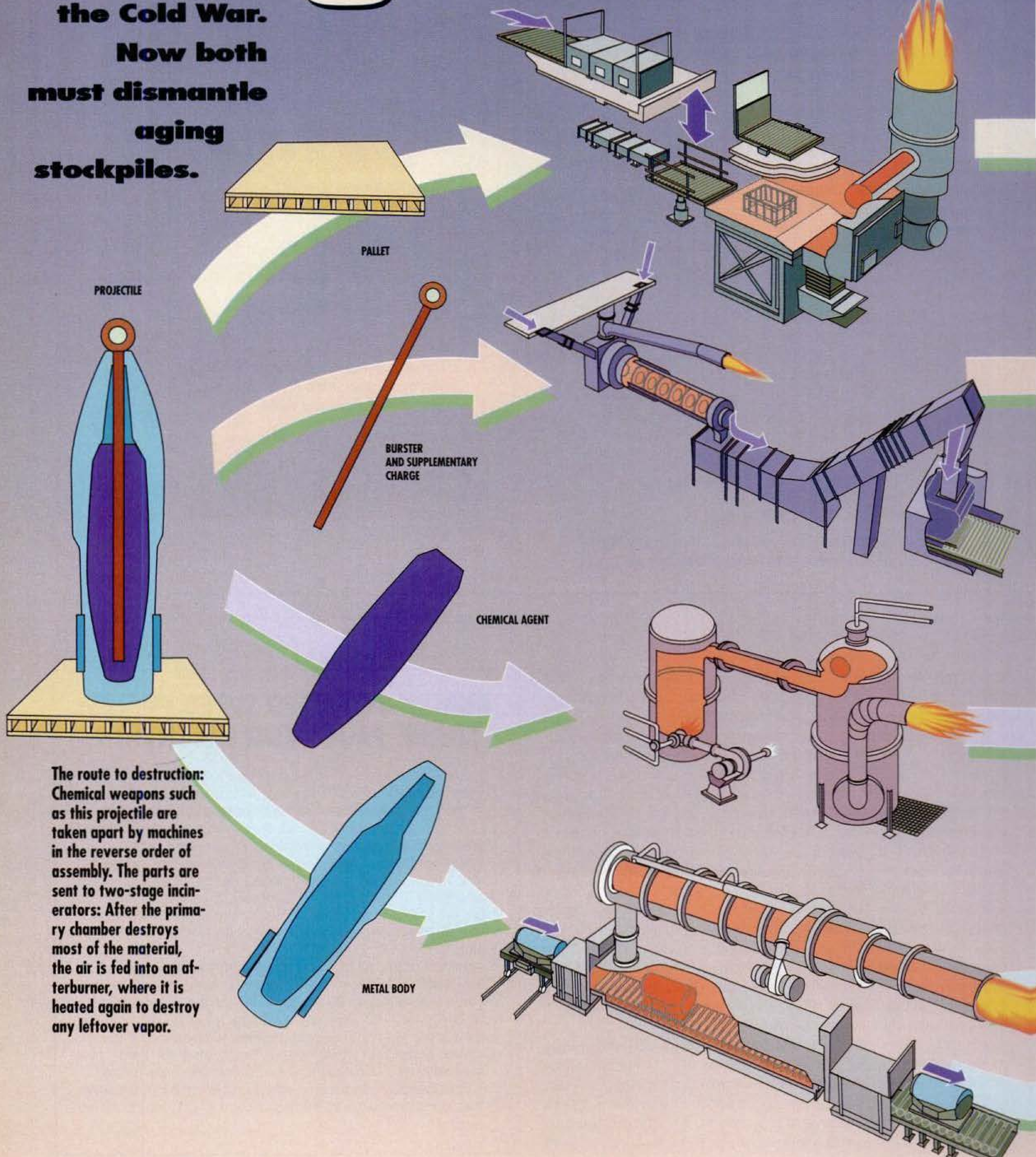
By tantalizing potential innovators with a measure of money and glory, the two human-powered speed competitions funded by chemical maker Du Pont have inspired some of the finest high-efficiency engineering ever.

In 1986, Nathan Dean and Gardner Martin took home the first Du Pont human-powered speed prize of $18,000, which was offered to the builders of a bicycle or tricycle to reach 65 mph on level ground. Gold Rush, their streamlined two-wheeler, now resides in the Smithsonian Institution in Washington, D.C.

Admirers of the art of doing more with less can also look to *Decavitator* and *Flying Fish 20* for inspiration—even if neither made it all the way to 20 knots. Rules for the watercraft prize won by *Decavitator* were developed by a committee from the International Human-Powered Vehicle Association, the Indianapolis group that holds annual speed trials for land-, air-, and watercraft. Calculations showed that the right person in the right machine should be able to attain a 20-knot speed. Some human-power aficionados believe it still can be done.
—S. F. B.

CLEANING UP

The United States and Russia built chemical weapons for the Cold War. Now both must dismantle aging stockpiles.



The route to destruction: Chemical weapons such as this projectile are taken apart by machines in the reverse order of assembly. The parts are sent to two-stage incinerators: After the primary chamber destroys most of the material, the air is fed into an afterburner, where it is heated again to destroy any leftover vapor.

DEADLY CHEMICAL WEAPONS

BY MARIETTE DiCHRISTINA

Considered clumsy and imprecise by many military experts, chemical weapons are nonetheless lethal. They're also relatively easy to make: Known as "the poor man's atom bomb," they contain ingredients similar to those used in pesticides and fertilizers. What's difficult, the U.S. Army has found, is destroying the nation's stockpile of obsolete, deteriorating weapons.

Some 25,000 metric tons of these chemical warfare agents—packaged in rockets, bombs, land mines, artillery projectiles, spray tanks, and bulk containers—now languish at eight sites in the continental United States and one on a Pacific atoll. Some of the weapons are nearly five decades old.

Among the toxins in these weapons are GB (also called Sarin) and VX nerve agents; exposure to mere drops of these clear or straw-colored liquids can cause convulsions, vomiting, and death from respiratory failure in minutes. The sites also store blister agents—called mustards because of the taste they leave—that attack the skin, eyes, and lungs, and can be fatal in large doses.

The disposal deadline for these old weapons is 2004. According to Army estimates, the entire job will cost some $8 billion.

Before the practice was banned in 1972, the Army dumped chemical weapons in the Atlantic Ocean. The Army has also employed open-pit incinerators, burial, and evaporation. Neutralization, a method in which chemical agents are mixed with sodium hydroxide to produce less toxic compounds, defanged several million pounds of GB in the 1970s and early 1980s; it worked less well with mustards. Among the many reasons why the process was discontinued: It created a lot of waste, it was costly, and it left open the possibility that GB could reconstitute in the waste stream.

Incineration is the current choice. Since 1990, the Army has used it to destroy some 1,700 tons of chemicals and 34,000 rockets, containers, and projectiles at Johnston Island, 800 miles southwest of Honolulu. Similar facilities are planned for each U.S. site, with one nearly completed at Tooele Army Depot near Salt Lake City.

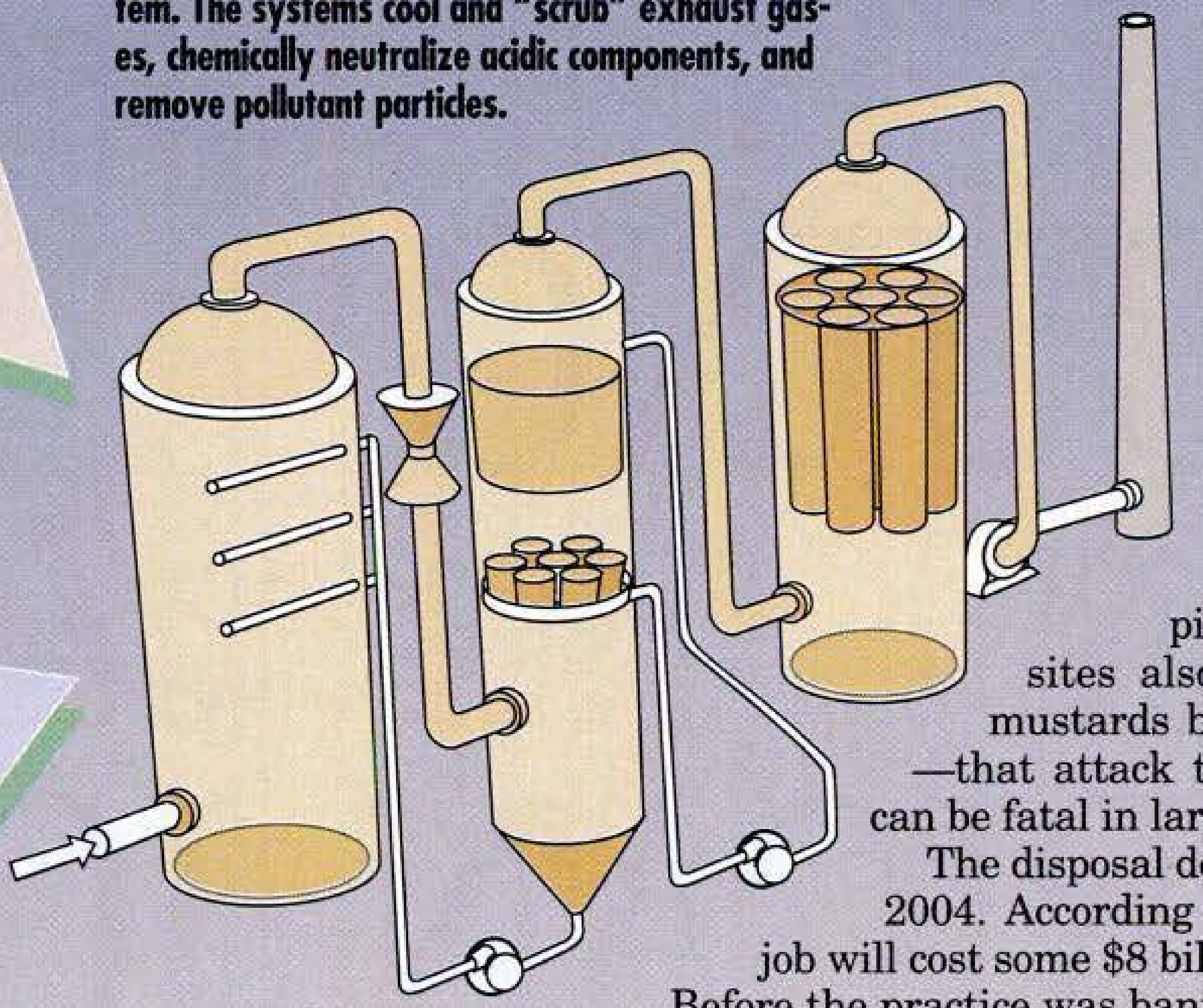
At Johnston, munitions are unpacked by hand, then taken apart by robots before being incinerated. "We have four very different waste streams, so we use four furnaces," explains Marilyn Tischbin, a

[Continued on page 90]

The dunnage incinerator handles packing material, wooden pallets, solid laboratory wastes, and spent charcoal used in air-filter units.

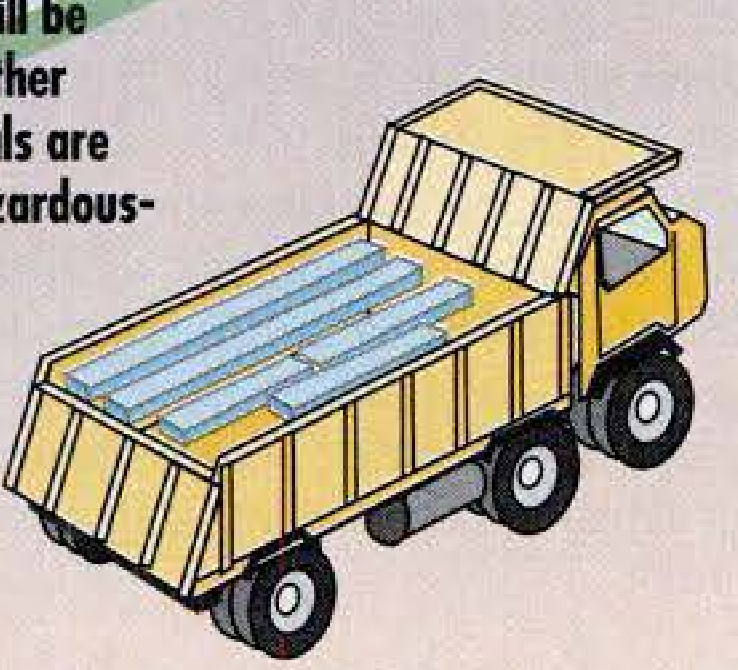
Explosives and propellants are incinerated in the deactivation furnace. Material that doesn't burn is sent to a heated discharge conveyor, where it remains for 15 minutes at 1,000°F to dispose of any remaining agent.

Each furnace has its own pollution-abatement system. The systems cool and "scrub" exhaust gases, chemically neutralize acidic components, and remove pollutant particles.



Operating at 2,700°F, the liquid incinerator destroys chemical agents drained from munitions, as well as organic liquid wastes, in a fraction of a second.

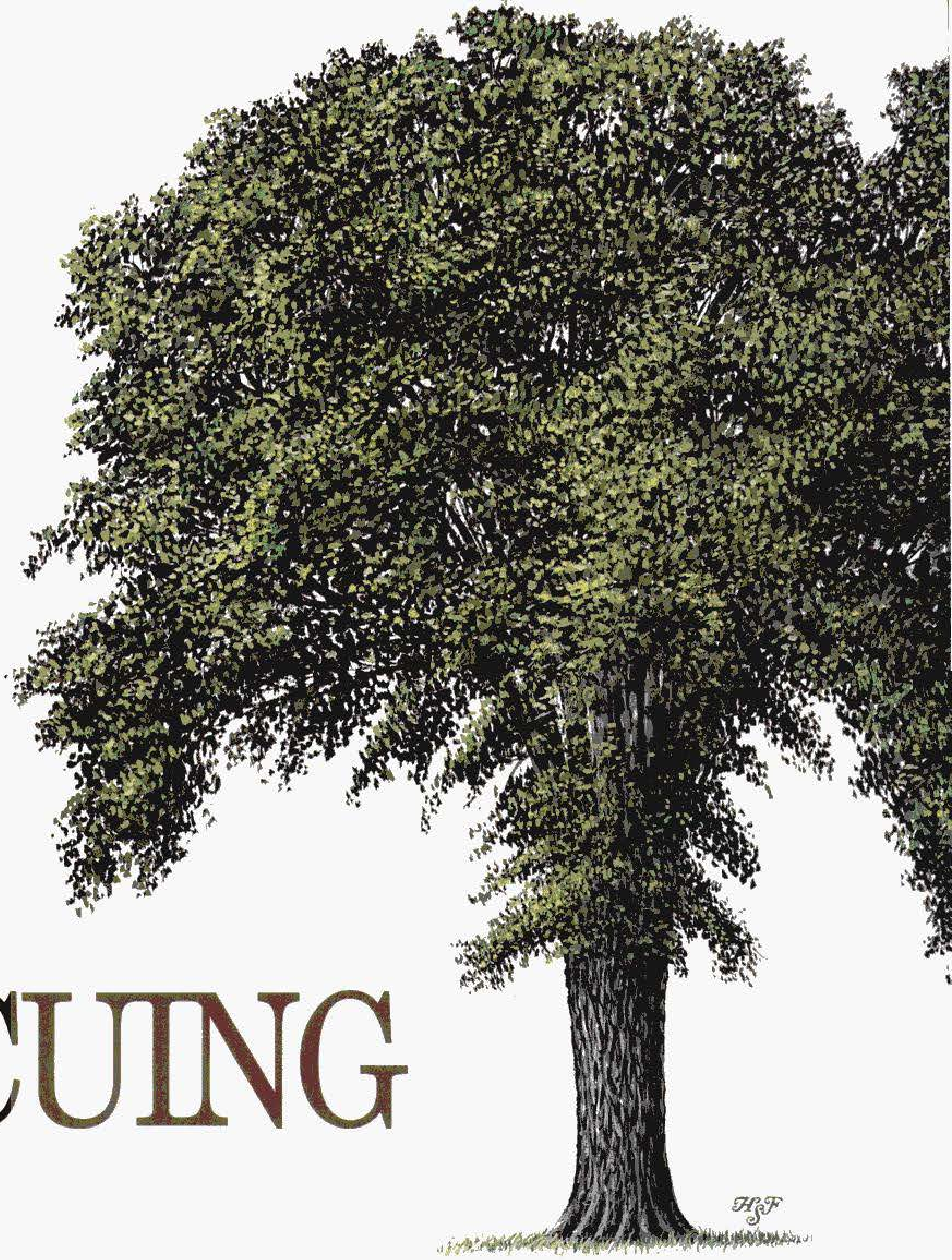
Metals remaining after incineration in the metal-parts furnace will be sold as scrap; other residual materials are shipped to a hazardous-waste landfill.



IAN WORPOLE

Decimated by Dutch elm disease, this country's stateliest tree is on the verge of a comeback.

BY MARIETTE DiCHRISTINA



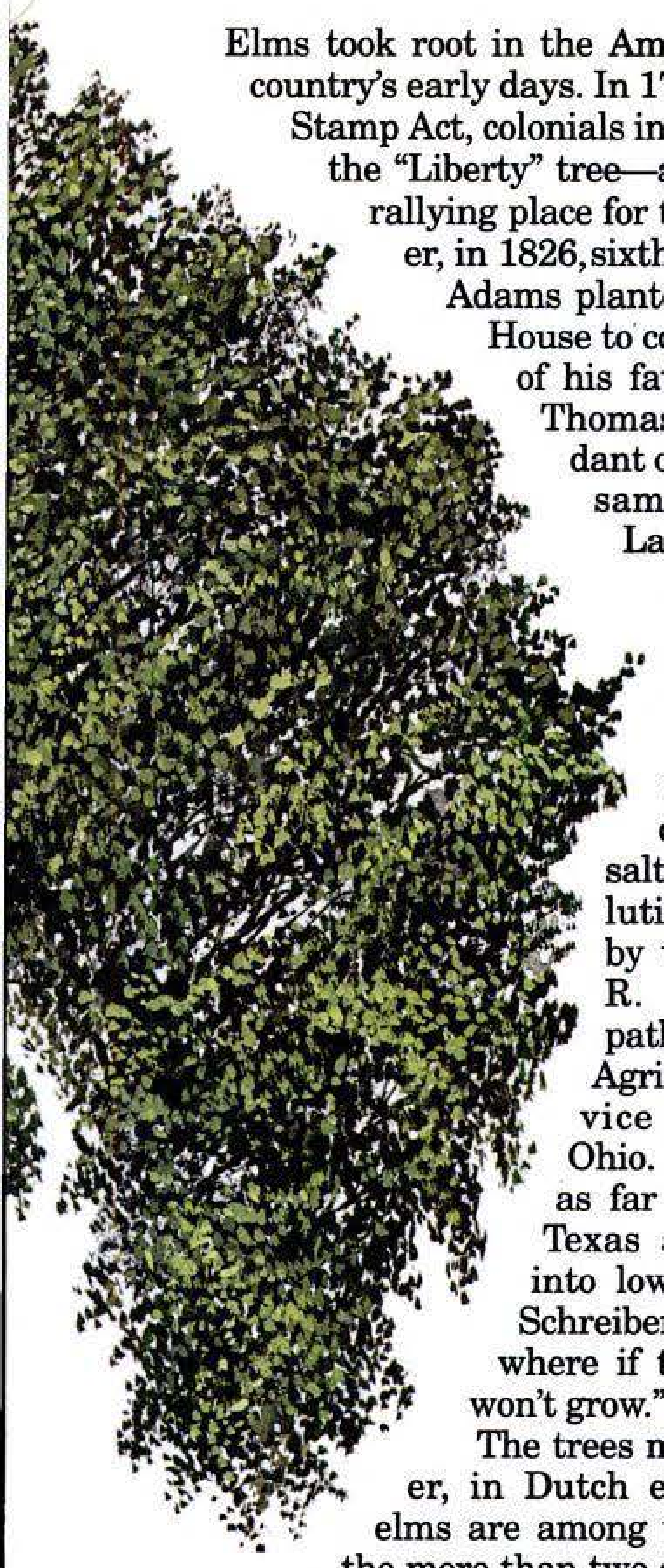
RESCUING AN AMERICAN ICON

Shaded streets lined by shoulder-to-shoulder American elms towering up to 100 feet tall . . . they are among the most deeply treasured images of American cities, retained in old photographs and fond memories. *Ulmus americana*, as the trees are known to science, were planted in great numbers from the turn of the century until the 1930s.

Like some of the old photographs, however, many of those trees have faded from view. Felled by the Dutch elm disease fungus, more than 90 percent of the estimated 77 million elms that were standing in cities in 1930 have since died, says Jack H. Barger of the U.S. Department of Agriculture Forest Service in Delaware, Ohio. Hundreds of millions of other elm trees that were outside the cities were also lost, he says; few areas of the country were unaffected.

But today there is increasing hope for the elm. Sixty years after the disease-causing fungus hit American soil, plant scientists are developing new defenses in this decades-old battle. In their labs, they are seeking the chemical keys to treating trees against the fungus as well as finding elms that are resistant to the disease. "With all the new technology in the areas of tissue culture and hybridization, there are new opportunities for looking at an old disease," says James L. Sherald, a plant pathologist with the National Park Service in Washington, D.C. Meanwhile, existing trees can be treated with fungicides. Dutch elm disease hasn't been eliminated, but some call the problem essentially "solved,"as long as Americans don't plant elms the way we used to—chockablock.

ILLUSTRATIONS BY HOWARD S. FREIDMAN



Elms took root in the American psyche from the country's early days. In 1765, to protest the hated Stamp Act, colonials in Boston hung effigies on the "Liberty" tree—an elm that served as a rallying place for the Sons of Liberty. Later, in 1826, sixth president John Quincy Adams planted an elm at the White House to commemorate the deaths of his father, John Adams, and Thomas Jefferson. A descendant of that tree stands in the same place on the South Lawn today.

As an urban answer to the desire for grand greenery, the elm's sturdiness was unparalleled. "There weren't many other trees that could withstand road salt, snow piled up, air pollution, and being banged by trucks," says Lawrence R. Schreiber, a plant pathologist at the USDA's Agricultural Research Service (ARS) in Delaware, Ohio. Elms ranged naturally as far west as the middle of Texas and from there north into lower Canada. But, adds Schreiber, "there are few places where if they're introduced they won't grow."

The trees met their match, however, in Dutch elm disease; American elms are among the most susceptible of the more than two dozen elm species. First described in 1921 in The Netherlands—hence the name—the epidemic traveled around 1930 to the East Coast on elm logs meant for veneer. The logs soon left a trail of elm devastation along their route to an Ohio furniture factory. When federal monies for removing diseased trees dried up during World War II, the disease was largely left to run rampant.

Planting practices compounded the problem. "Many of these trees were placed so close together that root grafting occurred," says Schreiber. The densely packed roots of different trees eventually merged and grew together in a functional graft. "If one tree became infected, the fungus would move right down the row," he says. Unclean pruning tools can also transmit the disease.

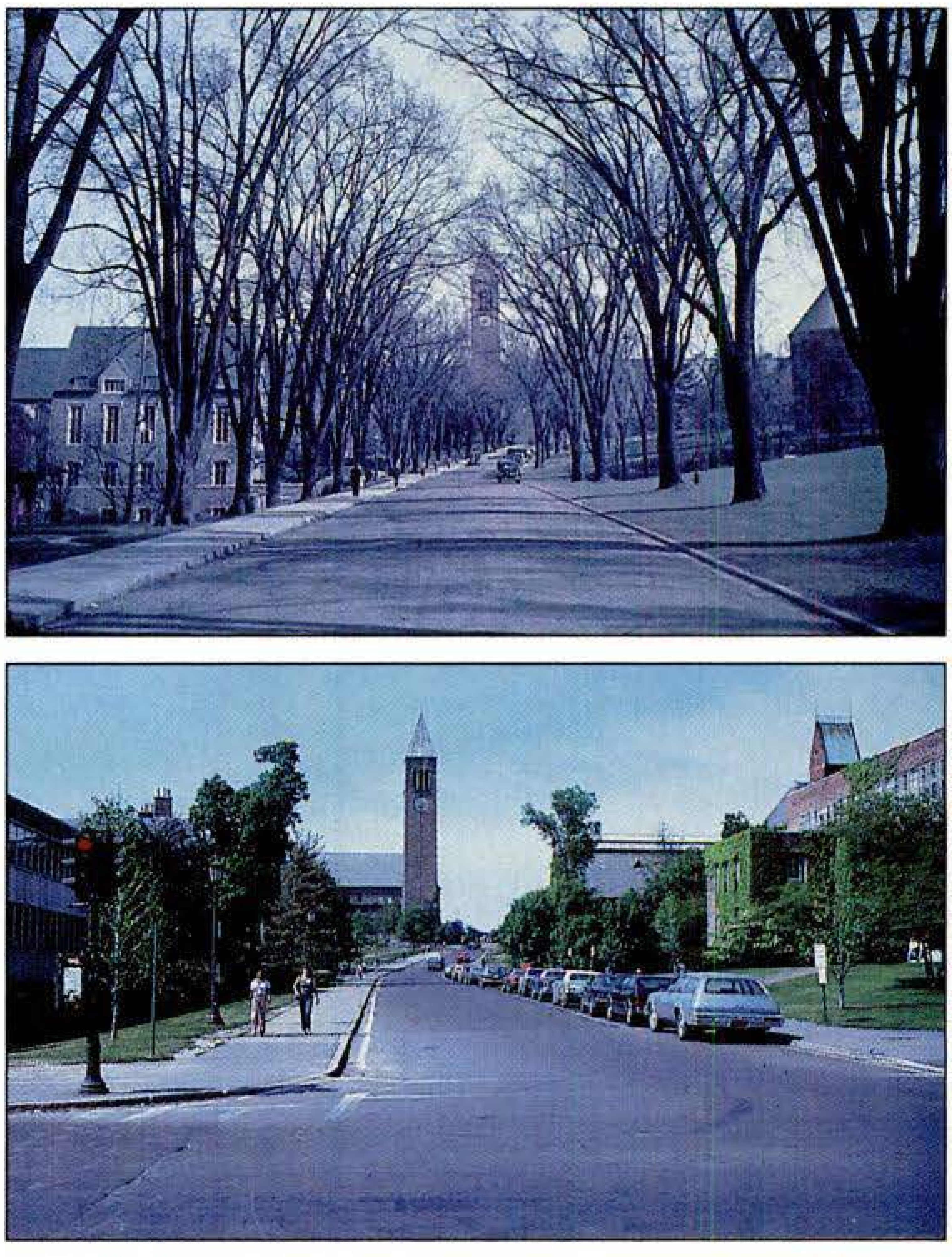
Above ground, the sticky fungus spores generally hitch a ride to their hosts on the body and mouth parts of elm bark beetles. Tunneling into trees that are dead or dying of Dutch elm disease, the beetles breed and lay eggs. When the new beetles emerge, they may feed—and deposit spores—at the twig crotches of healthy trees. The fungus, which can exist in several forms over its life cycle (see The Death and Life of an Elm Tree), then makes its way to the xylem, the water-carrying vessels of the tree. These vessels soon clog, choking off the tree's water supply. The first visible signs, called "flags," are leaves that discolor and wilt on a branch or branches. A young tree can die from Dutch elm disease in several months; a centuries-old giant may take years to succumb.

When the fungus attacks, it triggers a series of defenses inside the tree. Gums, gels, and bulbous wall thickenings called tyloses form in the xylem to stop the invader. "Unfortunately, the American elm reacts too slowly, walling itself off only after the fungus has moved," explains Bruce Fraedrich, a plant pathologist at F. A. Bartlett Tree Expert Co., a tree-care firm with research facilities in Charlotte, N.C. "Probably, the tree is killing itself," he adds, by cutting off nutrients and water.

In addition, the fungus and tree may engage in molecular-level chemical combat, through mechanisms that aren't fully understood. Preliminary research by a team of scientists led by Mariam B. Sticklen at Michigan State University in East Lansing and others suggests that fungus-produced compounds called cerato-ulmins could play a role in the attack. To study them further, the scientists have developed genetically engineered *E. coli* bacteria that produce the cerato-ulmins in large amounts. (This *E. coli* is not a toxic strain.) The research team has also isolated a chitinase enzyme gene from a resistant tree, which may be associated with resistance. Chitinase enzymes are known to be antifungal agents in some plants.

So far, though, "we simply do not know why certain species are resistant and others are susceptible," says Frank Santamour Jr., a research geneticist at the National Arboretum in Washington, D.C. "But then again we don't know why some people are susceptible to colds, and we've spent zillions of dollars on that." In the meantime, says Santamour, cultivating resistant trees is a good option: "The best thing to do is to inoculate a whole bunch of trees [with the fungus], cross a whole bunch of trees, reinoculate them, take the winners, propagate them, retest them, and so on."

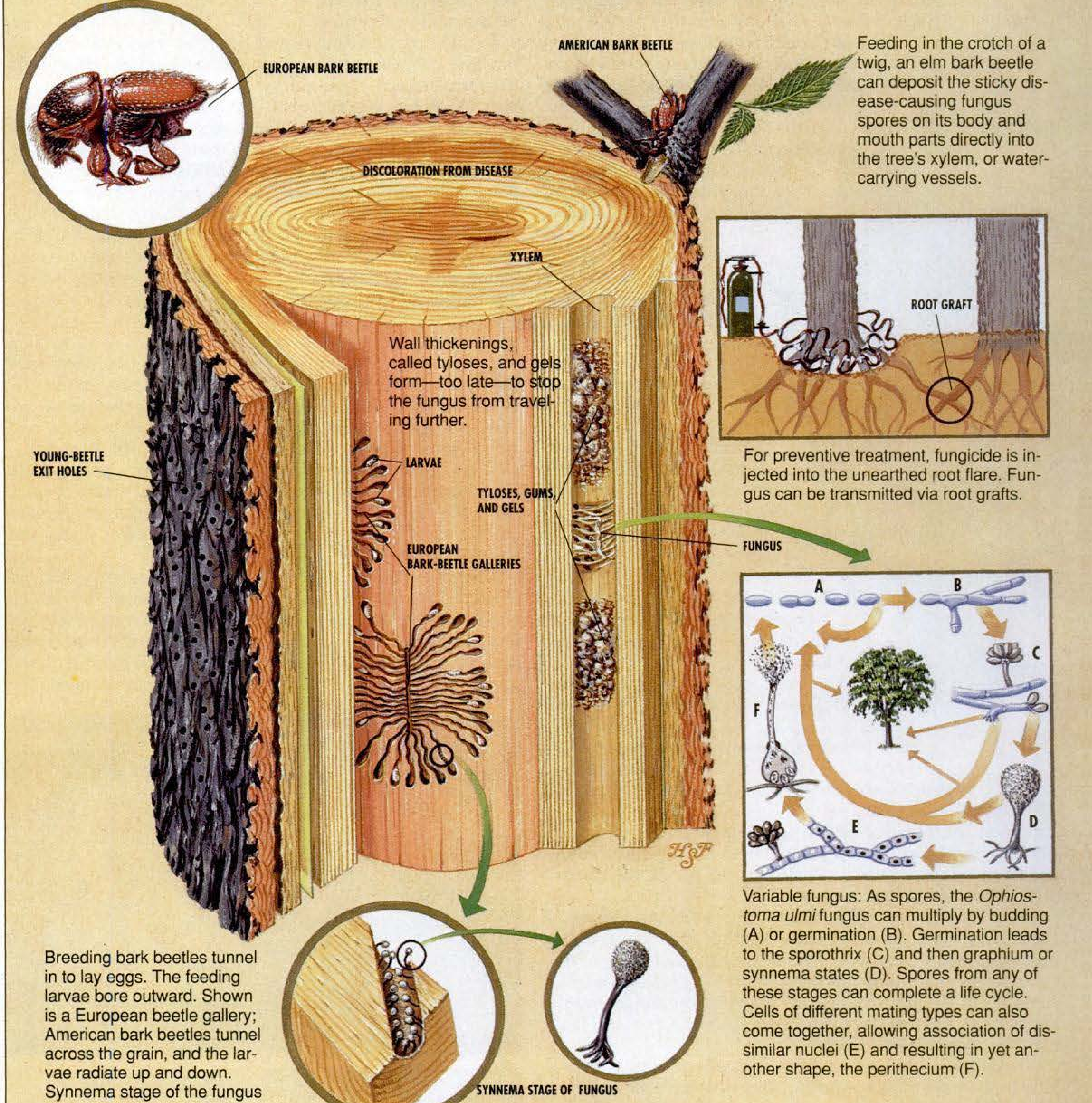
That's just what was done to develop the Liberty elm, derived from selected American elm seedlings. To do the screening, "we take a tree that is over three years of age, bore a hole in it, squirt fungus in it, and see whether the tree dies or not," says Eugene B. Smalley, the plant pathologist at the University of Wisconsin at Madison who headed



CORNELL UNIVERSITY

Before Dutch elm disease (top), the stately trees at Cornell University in Ithaca, N.Y., were common. The view today (above) is much changed.

THE DEATH AND LIFE OF AN ELM TREE



Feeding in the crotch of a twig, an elm bark beetle can deposit the sticky disease-causing fungus spores on its body and mouth parts directly into the tree's xylem, or water-carrying vessels.

Wall thickenings, called tyloses, and gels form—too late—to stop the fungus from traveling further.

For preventive treatment, fungicide is injected into the unearthed root flare. Fungus can be transmitted via root grafts.

Variable fungus: As spores, the *Ophiostoma ulmi* fungus can multiply by budding (A) or germination (B). Germination leads to the sporothrix (C) and then graphium or synnema states (D). Spores from any of these stages can complete a life cycle. Cells of different mating types can also come together, allowing association of dissimilar nuclei (E) and resulting in yet another shape, the perithecium (F).

Breeding bark beetles tunnel in to lay eggs. The feeding larvae bore outward. Shown is a European beetle gallery; American bark beetles tunnel across the grain, and the larvae radiate up and down. Synnema stage of the fungus can form in these galleries.

the Liberty elm research. Another method Smalley uses is to put fungus on small, debarked pieces of young trees in petri dishes; brown spots form quickly on pieces from resistant elms. More than a decade of such testing and selecting resulted in six trees that became the Liberty elms.

Named after the colonials' Liberty tree, these elms are distributed solely by the Elm Research Institute in Harrisville, N.H. Since 1984, it has shipped about 250,000—even the Boy Scouts plant the trees under the institute-sponsored Johnny Elmseed program. Other resistant American elms are also being developed, says Alden M. Townsend, a research geneticist at the National Arboretum in Washington, D.C. "We now have about 20 clones that look good," he says, "and they could be released to the trade in a year or so."

Far more resistant are hybrid Asian and European trees, though Schreiber cautions that none of them is immune. About a half-dozen of these varieties are now sold. Among the latest offerings from the Agricultural Research Service are Frontier, a cross of Chinese and European elms, and Prospector, from selected seedlings of another Asian elm.

With a mature height of 35 to 40 feet, the European and Asian hybrids are one-third the size of the American variety—a drawback to some elm fanciers. "We basically want to have our cake and eat it too," says Sherald, who oversees care for the 2,500 elms around the nation's capitol buildings and monuments. "We want a tree that looks like an American elm but is resistant to Dutch elm disease."

Sherald may have found an answer in a natural hybrid of an American and what may be an Asian elm. While it is difficult to cross these trees in the laboratory—the American elm has twice as many chromosomes as any other elm species—nature may have done so. Sherald's find, dubbed NPS 3-487, descended from one of the original 600 trees planted in the 1930s on the Washington Mall between the Capitol and the Washington Monument.

Serendipitously, Smalley has also encountered and is now developing Chinese-American hybrids. "It came about as an accident," he says. "We were doing some fall pollinations of the Chinese elm, and we used American elm pollen from the spring as a control. We got some seedlings, so we went back and did it again on a larger scale."

Geneticist Santamour, who helped analyze Sherald's resistant elm tree, sniffs at American elm purists. "OK, they're not true American elms," he says, "but I don't care. If it looks like an American elm, walks like an American elm, it's probably a duck—you know?"

Some 10 to 15 years of research can go into selecting resistant hybrids. To speed the process, Schreiber, ARS colleague Subash C. Domir, and others are experimenting with callus, an orange, oatmeal-like material from elm leaf tissue. It's grown in petri dishes and challenged with the fungus. If the callus is resistant to Dutch elm disease, the fungus growth is restricted. Callus that withstands the fungus could then be painstakingly grown into a resistant tree. The method has been used successfully for screening tomatoes and potatoes, but elms remain a challenge, says Domir. While the callus from days-old seedlings can be regenerated into a tree, Domir has found that the callus of mature trees cannot be grown reliably. Working with the callus of juvenile trees isn't the answer to the search for quicker screening, because, he says, "you don't know whether that young seedling would be resistant or not."

Instead, Domir and others are seeking to insert fungus-fighting genes into callus or other tree tissue—an idea that potentially gets around the mature-tree callus problem. Eventually, the work could bestow other desirable features on resistant trees, such as the vase shape of the traditional American elm crown and resistance to other tree diseases.

"Of course," notes Schreiber, "disease-resistant trees don't do a doggone thing to help trees that are already out there and are susceptible." Though expensive to implement on a large scale, good sanitation and fungicides can help.

Around the buildings and monuments of the nation's capitol, Sherald says sanitation helps keep elm losses to 1 percent a year. Similar results are achieved by Elm Research Institute volunteers. With a name that perhaps reflects the group's 1970s origins, the Conscientious Injectors have inoculated about 100,000 trees with a 95 percent success rate.

For sanitation, "we inject fungicides and prune out the infected limb of a diseased tree," says Sherald. "If it's beyond one major limb we will not usually make the effort, because the disease has gone systemically throughout the tree and the chances of saving it are nil." Diseased trees are removed as soon as possible, to prevent them from becoming home to breeding bark beetles or a reservoir for the fungus.

New field tools offer other advantages. The new Alamo fungicide from Ciba-Geigy Corp. may be the first to stop fungus transmission via root grafting, says Fraedrich, the

[*Continued on page 89*]

AMERICAN CHESTNUTS: DOWN, BUT NOT OUT

While American elms were king of the urban jungle, chestnuts dominated the forests; in Appalachia, for example, one in four trees was an American chestnut. This useful tree ranged from Maine to Georgia to the Mississippi River, providing natives and early settlers with sweet nuts, bark for tanning leather, and durable, rot-resistant lumber.

Chestnut blight was inadvertently introduced around the turn of the century via Asian chestnuts planted at New York's Bronx Zoo. After nine decades, an estimated four billion American chestnut trees have died.

Though the mature trees became virtually extinct by the 1950s, the chestnut itself dies hard. The blight-causing fungus can't survive in the soil, so it doesn't kill the whole tree. Shoots can spring out of decades-old stumps; the blight makes these die back.

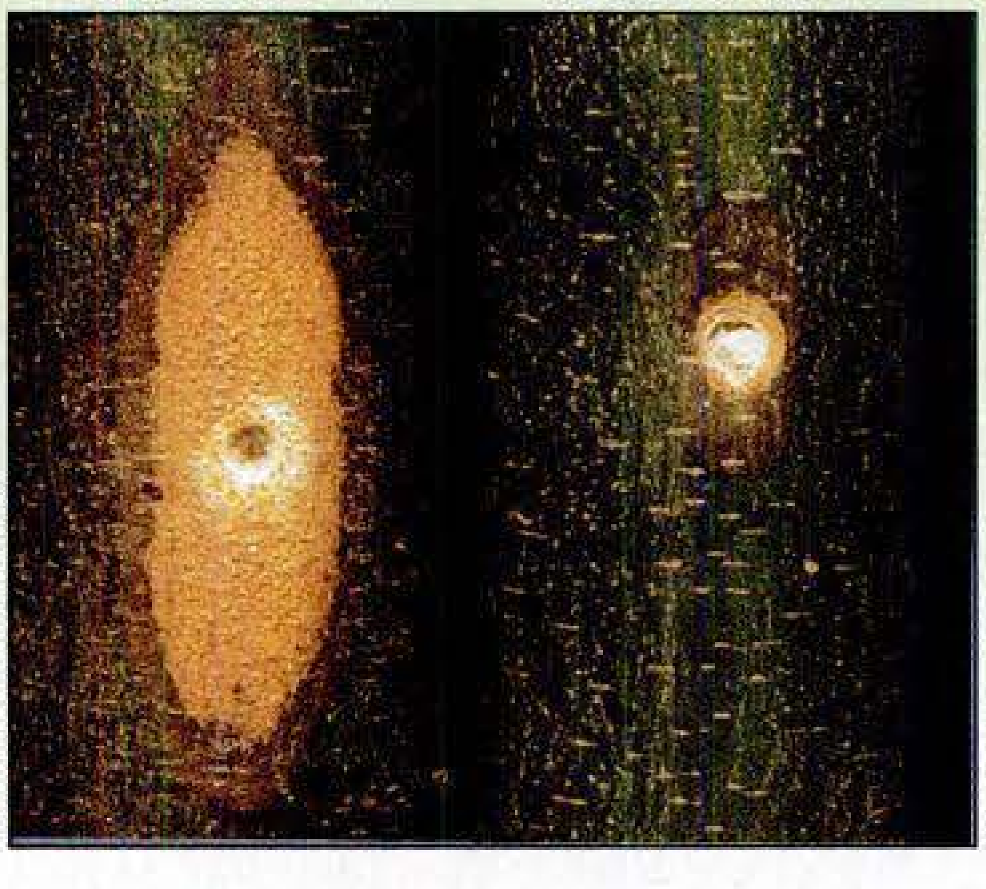
A promising treatment developed by two researchers at the Roche Institute of Molecular Biology in Nutley, N.J., could enable the stumps to grow up again. Gil H. Choi and Donald L. Nuss have produced synthetic viruses that convert the deadly blight fungus to a more benign form. Spores from the converted fungus could be sprayed on infected stumps. The altered fungus would breed with the virulent form, rendering it benign.

In the 1950s, a milder hypovirulent version of the blight appeared naturally in Europe, but its traits weren't passed consistently to future generations. The engineered hypovirulent strains, however, will breed true.

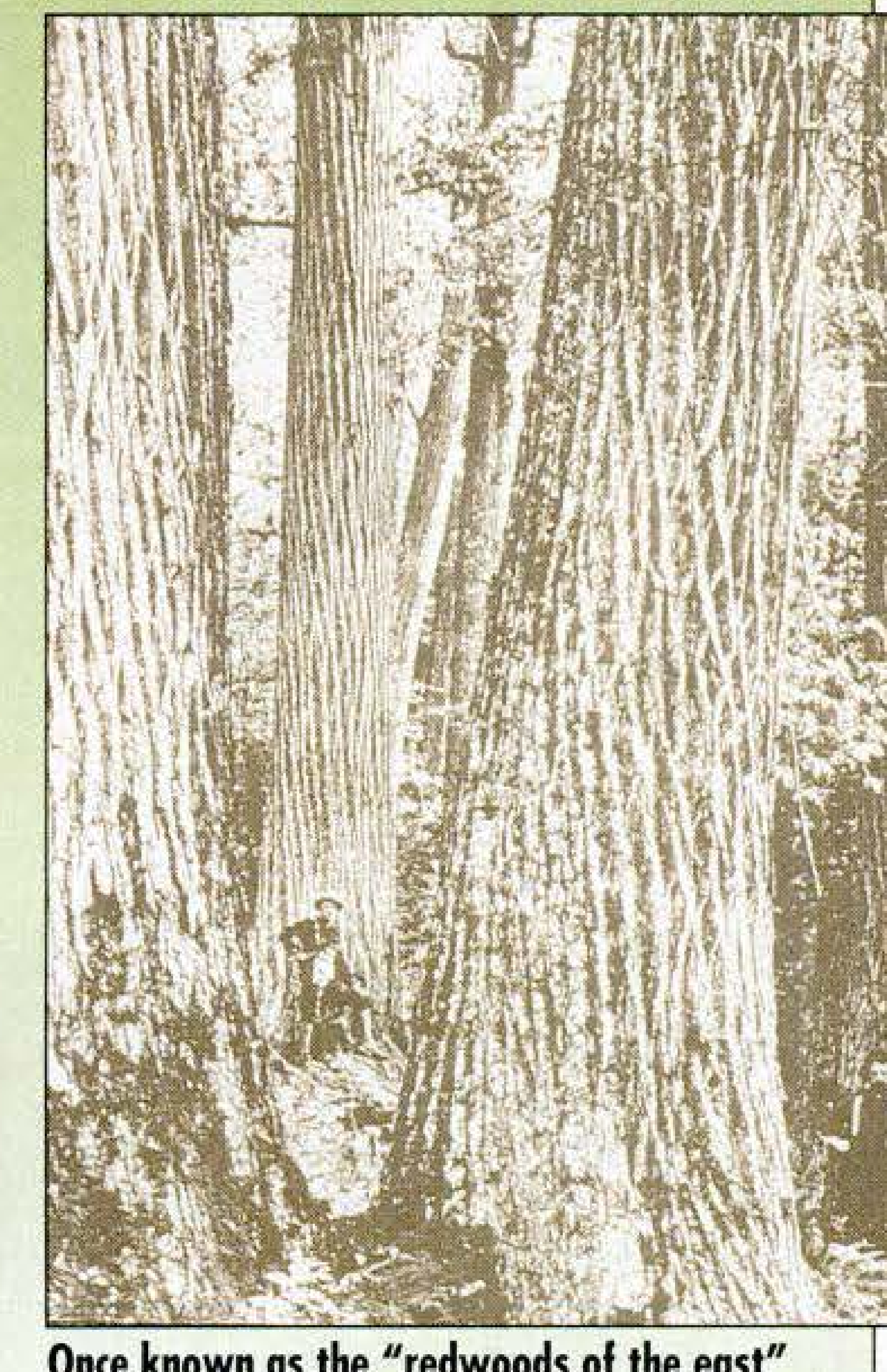
The hypovirulent fungus behaves like virulent strains, but simply isn't as capable an attacker. Like the virulent strain, the altered fungus enters through small cracks in the bark. In the virulent form, tendrils of fungus mycelia invade and fan around the chestnut's cambium (actively growing cellular tissue), stopping nutrient flow and killing the tree. "But the hypovirulent fungus can't penetrate effectively," explains Nuss. "The tree closes over it by forming callus tissue."

Nuss and Choi are applying for permission to release the spores outdoors. Nuss says such test trials could be allowed by next year.

The chestnut treatment has broad implications, says Nuss. "It's a model system to demonstrate the concept of engineering a virus to control fungal diseases," including, potentially, Dutch elm disease.—*M. D.*



HOFFMAN-LA ROCHE, INC.



MUSEUM OF NORTH IDAHO

Once known as the "redwoods of the east" (above), mature American chestnuts are nearly extinct, victims of a blight. A genetically engineered strain, however, causes smaller lesions than the natural blight (left). The chestnut can overcome the new strain, and live.

Pilots fly safely in pea-soup conditions using sensory-enhancing systems. Someday, drivers will navigate the roads using similar devices.

The EXTRAS

BY DAN McCOSH

A blind man driving a Ferrari—the role that won Al Pacino an Oscar in the movie *Scent of a Woman*—may be the ultimate inspiration for automotive engineers working on advanced, high-tech vision systems. But sometimes even driving with good eyesight on a rain-blackened road at night isn't much better.

As uncomfortable as the thought is, there are times while driving when you are at the limits of perception of sight and sound, as well as your reflexes. Simple mathematics is against you at 60 mph. If visibility at the end of normal headlight range drops to 200 feet, it means that, within that distance, you must discern an object obstructing the roadway ahead and hit the brakes in a full panic stop in less than a second if you are going to avoid a collision. Less dramatic, but still hazardous, are the times spent fiddling with the radio, looking backward with a substantial portion of your vision blocked, or entering an intersection with traffic obscured in several directions, when you might as well be using a white cane.

But driving blind under these circumstances may soon give way to an array of high-tech sensing, control, and navigation devices that have the potential to greatly expand the senses and reflexes of the average driver. They operate much the same way as aircraft instrumentation, landing, and navigation systems, which enhance the reflexes and senses of pilots and allow takeoffs and landings under formerly unthinkable conditions.

The aircraft analogy goes even further: Night-vision systems, radar braking, laser ranging, rearview blind-spot detection, and other sensory-enhancing systems under review for fu-

ILLUSTRATIONS BY ROBERT ROPER

ENSORY
Car

ture cars were, in many cases, originally developed for combat aircraft. The challenge has been to make these high-tech systems both affordable and practical in more mundane applications. Any newfangled system introduced into the familiar environment of the family car must be straightforward, low cost, and extremely reliable.

The latest research on systems loosely grouped under the heading "collision avoidance" has moved from developing practical hardware to examining exactly how a driver can be expected to respond to a new and potentially bewildering variety of inputs and information. The technology has the potential to be expanded from a passive warning to actively taking control in certain situations. It could even monitor the driver to see whether he is paying attention or is falling asleep at the wheel.

What is emerging is a new view of the driving experience, with electronics enhancing or even substituting for human sight, hearing, and reflexes. "We are looking at extending the senses and compensating for driver errors," says Dr. David C. Viano, head of General Motors' biomedical science department, which recently began expanding its mission from studying how to survive a crash to how to avoid one in the first place.

"The first line of activities is designing the sensors; then when you have the sensors, how do you feed back cues to the driver," asks Viano. It's a complex problem that has short-term possibilities and long-term goals. Hardware already on the shelf includes several types of ranging devices—adaptions of radar, lasers, or ultrasonic echoing systems that do a good job of detecting objects well beyond the range of normal vision, and, perhaps more important, of calculating range and speed of those objects.

Even the simplest applications tend to have complex side effects, however. This is illustrated by a small Doppler-effect radar recently unveiled by GM's Delco division, which works on automotive systems with GM-owned Hughes Aircraft. The radar detects schoolchildren who are near a stopped school bus but are out of sight of the bus driver.

There have been several attempts at this kind of blind-spot detection in the recent past, including an infrared detection system and several ultrasonic devices. The systems detect objects reasonably well, but they are easily fooled by any small object, including fire hydrants or piles of snow. To solve this problem, engineers at Hughes have adapted a lightweight radar originally developed as a low-altitude altimeter for combat helicopters. The radar emits a fan-shaped beam that covers a defined area. A stationary object can be distinguished from a moving object in the detection area by a computer that checks for differences in the rate of change of the returning signal. As a result, motion can be detected without the use of a complicated mechanical scanning antenna. The array consists of two electronic antennas—one at the front and one alongside the school bus, with a simple warning buzzer and flasher inside next to the driver. Already approved in half the states, the device is being credited for saving lives, as well as being relatively free of false alarms.

This simple radar system is being tested for additional applications likely to appear on production cars in a few years—including a radar-controlled cruise control that automatically adjusts vehicle speed when approaching a car ahead and resumes the set speed when the road is clear. But even this simple exercise presents a problem common to most on-board radar systems: the inability to distinguish between objects ahead in the same lane and targets in the line of sight on the outside of a curve.

This kind of false alarm is irritating but not dangerous for a simple cruise-control system—it only slows the car momentarily. But if the system is expanded to activate the brakes, or even generate a panic stop when it senses an impending collision, target identification becomes much more critical. "You need an extremely low false-alarm rate under these conditions," notes Gene Farber, head of Ford's human factors research department.

It's a problem with a seemingly simple solution: Tag the car ahead with a reflector that allows it to be quickly separated from the trees, bushes, and lampposts on the side of the road, as well as oncoming traffic in the opposite lane. Just such a system is already being tested by Nissan in Japan, using a laser beamed from the front of the vehicle to a reflector on the car ahead.

But any setup that requires modification of all the cars on the road, or even adding new technology to the existing highway network, means a radical change in the infrastructure, rather than simply a new gadget for certain new cars. Virtually any system that needs support from outside the individual vehicle comes under the broad category of so-called Intelligent Vehicle Highway Systems (IVHS), which lately have been the focus of considerable government-sponsored effort and funding. IVHS covers a broad range of technologies, including communications and navigation systems and highway designs to enhance traffic control. These networks are the ultimate in collision avoidance, since some are able to identify the speed and position of any car in the system, much like aircraft instrument landing setups.

Waiting for any standardized traffic-control system to be adopted and installed nationwide could take decades, if one is ever adopted at all. Federal research programs on developing a basic traffic-control network are expected to be announced soon. Meanwhile, developing free-standing, on-board ranging and sensing devices does not have to wait. These could be installed as soon as they become proven.

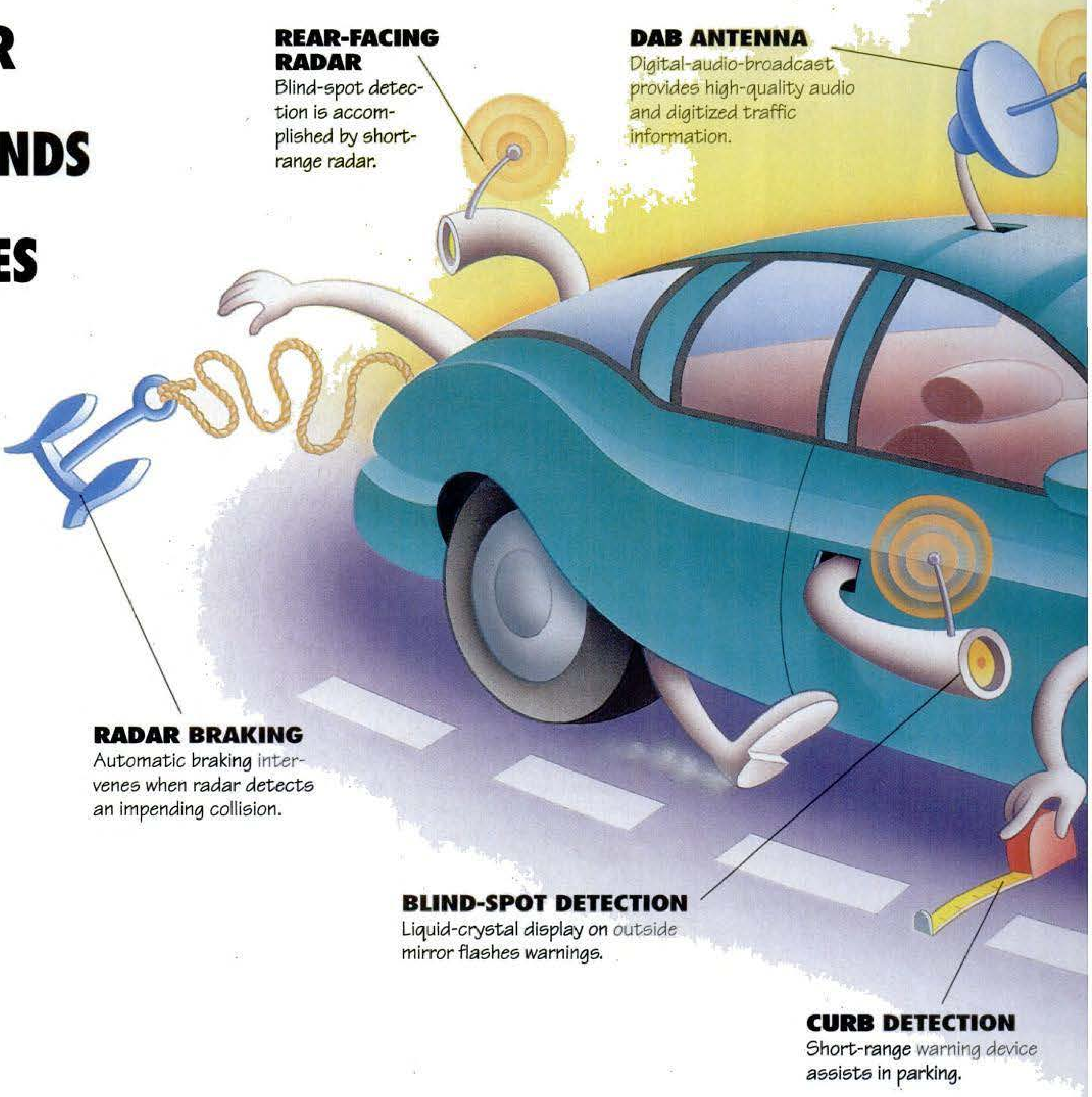
One of the more intriguing on-board setups is a night-vision system that detects infrared radiation from both objects on the road and the surrounding landscape. Originally developed to enhance the nighttime movements of troops, night-vision binoculars are available today in boating catalogs. Minneapolis-based Honeywell Inc. recently announced a simplified night-vision system suitable for automobiles that could be on the road in a few years as a $2,000 option.

Heat-sensing vision systems cut through light fog, make headlight glare invisible, and pick out children on the side of the road who would be invisible outside the range of normal headlights. But night vision, which is normally displayed on either a cathode-ray screen or in self-contained goggles, presents a significant perceptual problem when it is installed in a car.

"The greatest challenge is the interface between the driver and the vehicle," notes GM's Viano. The possibilities of how to display night vision range from an in-the-dash CRT display that can be referred to occasionally like a rearview mirror, to a modified head-up display (HUD), which actually recreates the night-vision image in the driver's line of sight, superimposed on the normally illuminated view through the windshield.

The latter approach is striking. On a darkened road, the night-vision system appears as a greenish area in a portion of the windshield, where contrast is reversed; hot spots such as people appear darkened. The system does two things at once to your normal view at night: It enhances and alters color and contrast, and introduces a time lag as the infrared image is processed. The subtle

A CAR THAT EXPANDS THE SENSES



REAR-FACING RADAR
Blind-spot detection is accomplished by short-range radar.

DAB ANTENNA
Digital-audio-broadcast provides high-quality audio and digitized traffic information.

RADAR BRAKING
Automatic braking intervenes when radar detects an impending collision.

BLIND-SPOT DETECTION
Liquid-crystal display on outside mirror flashes warnings.

CURB DETECTION
Short-range warning device assists in parking.

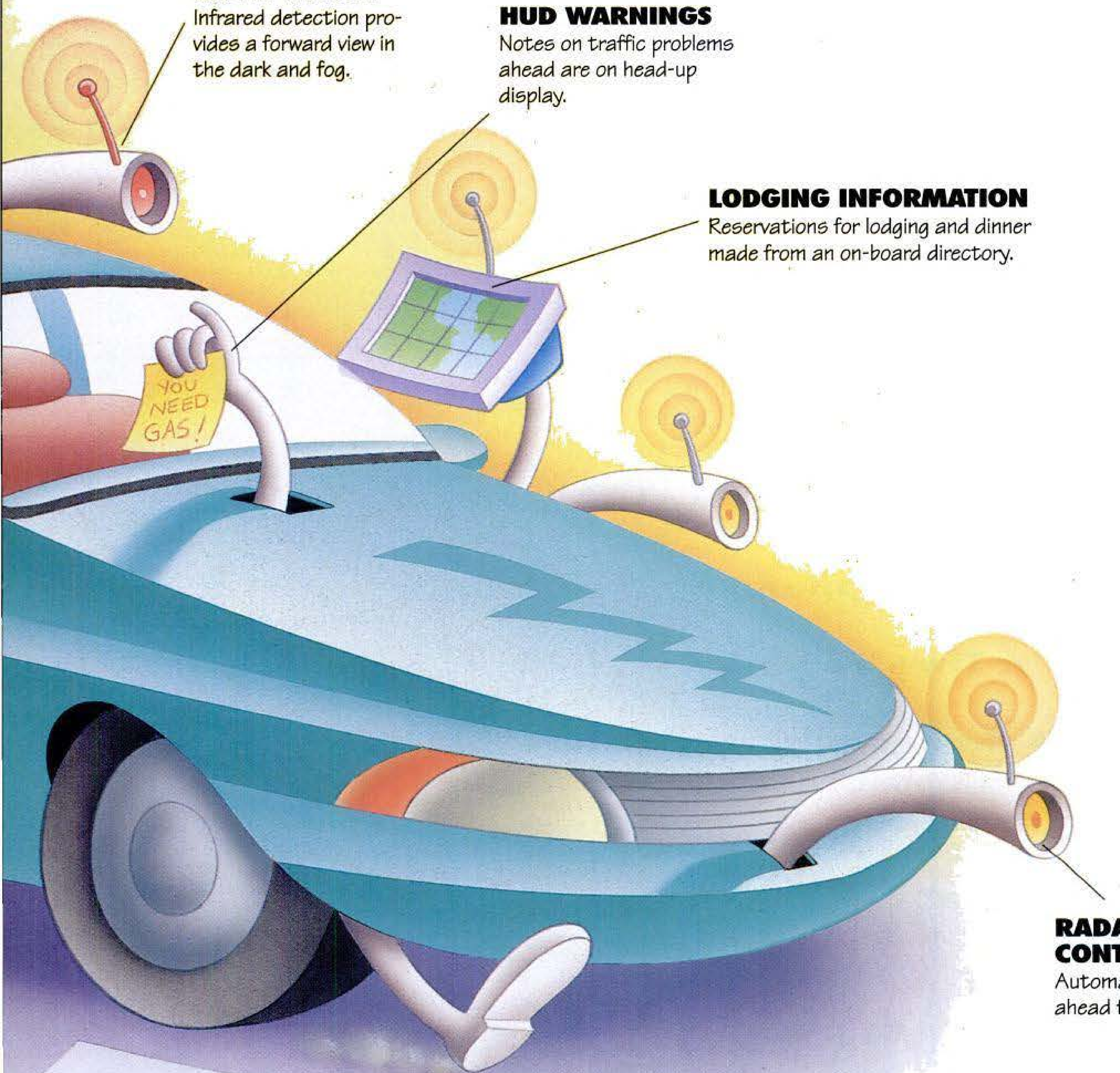
distortion of time is disconcerting, to say the least, and is a strong argument for placing the display out of the driver's primary field of vision. Furthermore, the night-vision display is only one facet of a larger display problem, when extra senses become incorporated in an automobile cockpit. "In 20 years, we could have as many as 20 different sensors, and we don't want to confuse the driver," says Viano.

GM is working to solve this through its Hughes Aircraft division, which had similar problems in displaying up to 100 different warning devices in an aircraft cockpit. The solution there is "layering" the warnings so they appear in the pilot's HUD only when they are needed. In combat, this means a bright flash if radar detects an oncoming missile. In a car, it could be considerably less dramatic—maybe a "hot engine" signal that only shows up when the engine is overheated or, more important, a visual warning displayed when a forward-facing radar detects an impending collision. Current HUD systems are for straight-ahead vision, but liquid-crystal rearview mirrors, already used to automatically dim and cut headlight glare, can be used as an effective display screen for rear-facing, blind-spot detecting radar as well.

A short ride in a van equipped with a HUD-based system fully integrated with complex navigation devices quickly demonstrated the advantages of a layered display. GM's Telepath demonstration van is laden with enough communication equipment to stock a CIA listening post. Digital-audio-broadcast reception provides a high-quality signal for the audio system and adds a high data-rate channel for digitized communication. A short-range transceiver with a 20- to 100-meter range is used for electronic toll collection and acts as an on-board highway sign system. Warnings such as "bridge out" are shown on the vehicle-to-roadside communication display.

A keyless entry system performs the normal functions of locking the doors, but also initializes the vehicle's navigation equipment, which uses the government's global-positioning satellite system to determine a more exact location than using dead-reckoning. The

[Continued on page 93]


NIGHT VISION
Infrared detection provides a forward view in the dark and fog.
HUD WARNINGS
Notes on traffic problems ahead are on head-up display.
LODGING INFORMATION
Reservations for lodging and dinner made from an on-board directory.
YOU NEED GAS!
RADAR CRUISE CONTROL
Automatically tracks car ahead for set speed.

JOHN B. CARNETT

Instant privacy: Electrochromic windows, such as this one in the GE Plastics test house in Pittsfield, Mass., can turn opaque when current is cut off.

WINDOW TECHNOLOGY: PART TWO

Now you see through them, now you don't: They're windows that change with the flick of a switch.

BY P. J. SKERRETT

THROUGH THE GLASS

DARKLY

Switchable glazings can solve a classic problem that architects have been struggling with for years and save us a tremendous amount of energy along the way."

That's Stephen Selkowitz, *the* expert on windows and daylighting in the United States. On a hot, sunny California afternoon, he is describing the ultimate window: an insulated, multi-pane, high-tech device that automatically switches from clear to dark and back again, capturing as much light as possible while rejecting unneeded heat.

Just a researcher's dream? Not at all. The pieces of this futuristic "smart" window already exist today. Though some are still laboratory prototypes, a few semi-intelligent glazings have hit the market. Usable, affordable smart windows could begin appearing on office buildings and in hardware stores by 1995, say optimistic researchers. While more cautious analysts peg the debut to be around the turn of the century, all agree on one thing—this technology is so useful it will soon be in demand, especially as energy prices climb.

The reason is inherent in the limitations of today's windows—even in the latest energy-efficient superwindows ["Window Technology Part 1: No Pane, No Gain," June]. Want to illuminate a home or office as inexpensively as possible? Build huge windows that capture lots of light. Unfortunately, the heat that inevitably comes along with it increases the amount of electricity needed for air-conditioning. Minimize cooling costs by limiting window size, and you automatically boost the use of electricity for lighting. That balancing act is what Selkowitz, director of Lawrence Berkeley Laboratory's Windows and Daylighting group in California, calls the "classic problem."

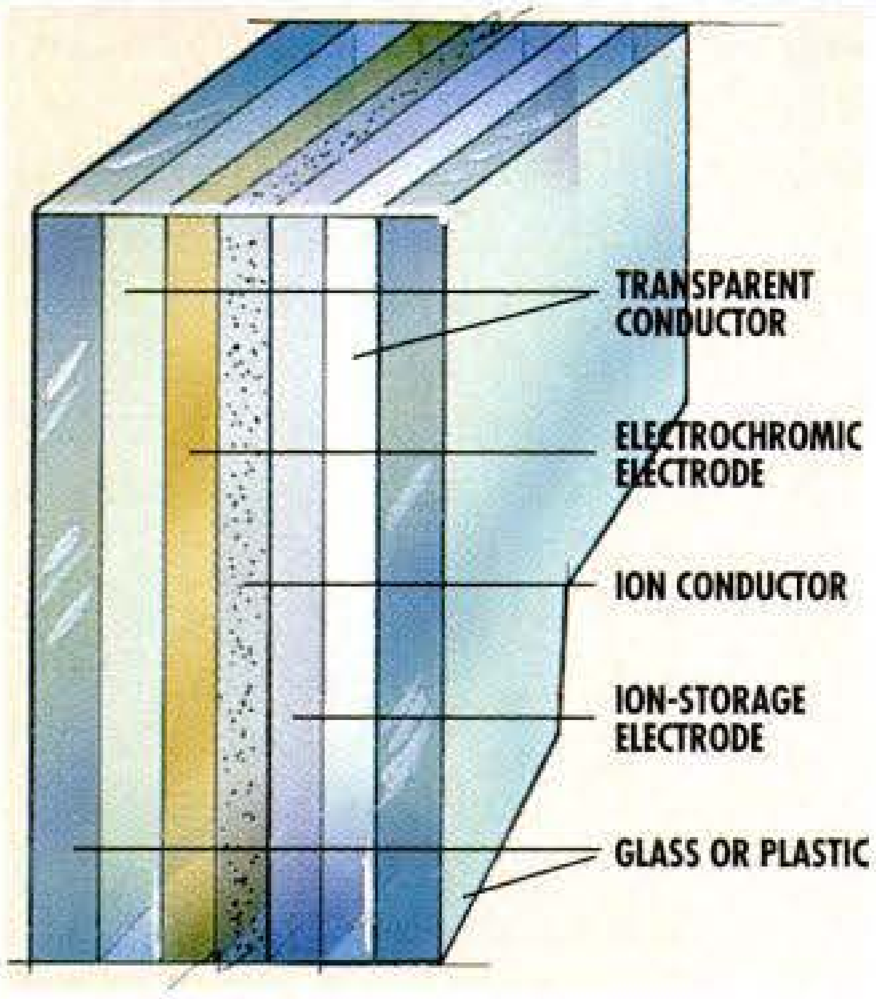
Tinted windows can prevent overheating in summer, but they also screen out useful heat during the winter and can darken an interior so much that electric lighting must be used all day. Shades make a manually "switched" window, but they aren't all that efficient, says Selkowitz as he fiddles with the blinds in his office to block the late afternoon sun. One recent study from the Lawrence Berkeley group modeled window use in a California office building and found that switchable glazings would cut electricity use in half, compared with tinted windows.

A handful of companies, from giants like PPG and 3M to the tiny two-man Molecular Displays, are working to develop smart glazings. Virtually all focus on electrochromic devices that darken or clear in response to a small electric current. The exception, Suntek, makes a thermochromic glazing called Cloud Gel that switches from clear to opaque when it warms beyond a certain temperature (see Cloudy to Clear).

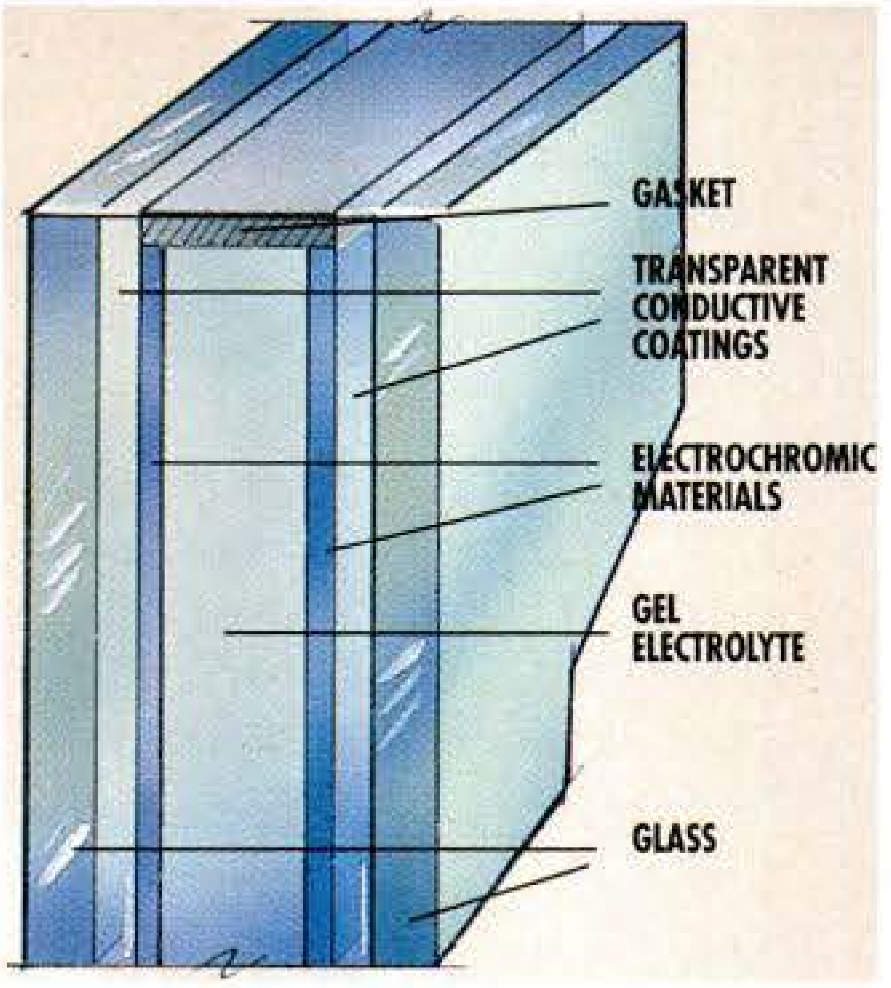
For controllable, see-through switchable windows, electrochromic glazings will be hard to beat. Deep blue or bronze when fully colored and barely tinted when bleached, these electrically controlled films can often also be adjusted to any hues in between. In addition to windows, engineers and designers are applying electrochromics to an ever-expanding range of applications—automobile mirrors and sunroofs, batteries, computer displays, and TV screens, to name a few.

Though different companies are banking on different types of materials, most electrochromic devices look and operate much the same. They are essentially multiple layers of compounds sandwiched between two conducting electrodes. At least one layer changes from clear to colored when oxidized or reduced, and another provides a steady flow of ions to keep the reaction running. Some devices make use of complicated organic chemicals, others rely solely on inorganic substances; some contain a semisolid or liquid layer, while still others take the solid-state route.

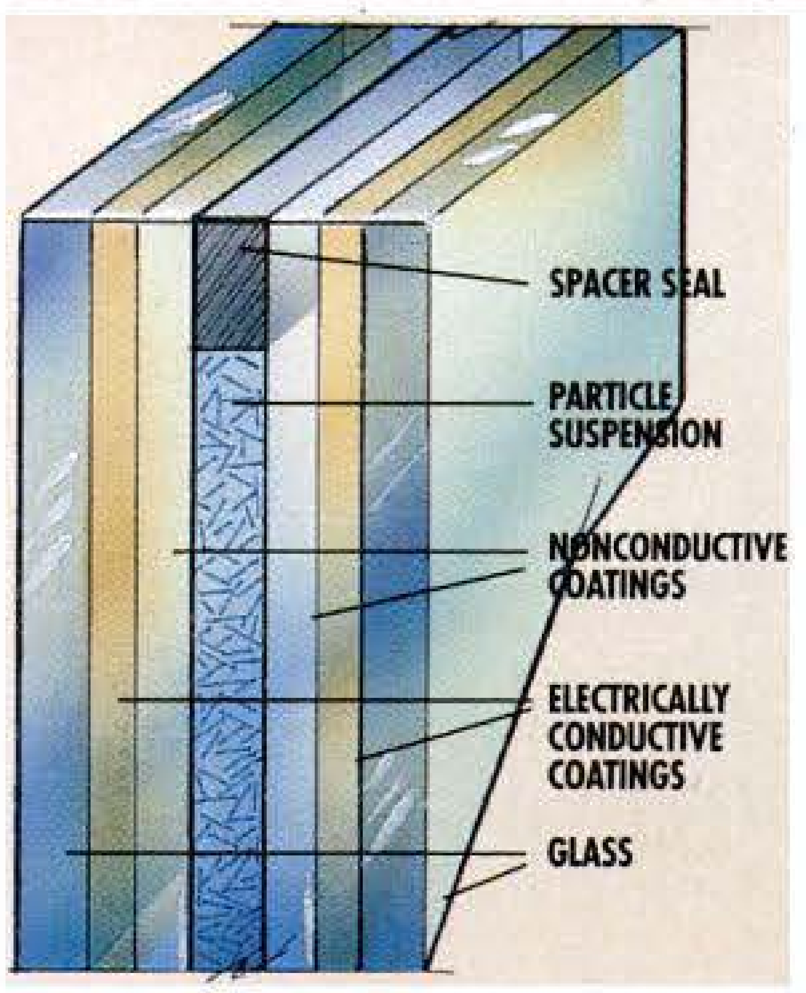
THREE ROUTES TO SWITCHABLE WINDOWS



Proponents of solid-state electrochromics, such as this one from Lawrence Berkeley Laboratory, say it may last longer than organic liquid alternatives. The tungsten oxide colors from clear to opaque bronze when it picks up an electron and lithium ion.



In liquid-type electrochromic glazings, such as this example from Molecular Displays, a gel electrolyte separates two electrochromic polymers. These polymers change from clear to colored when subjected to 0.8 to 0.9 volts.



The suspended-particle display is colored in its uncharged state; powered, the polyiodide-crystal particles in suspension line up, and the display bleaches from deep blue to clear. Constant current is needed to maintain the clear state.

ILLUSTRATIONS BY JANA BRENNING

In their Cambridge, Mass., laboratory, electrochromic chemists Nicholas Leventis and Young Chung—the founders and entire staff of Molecular Displays—demonstrate the switchable window they have built. It's really just a small, barely blue electronic sandwich. Two thin pieces of glass, each coated on the inside with a transparent film of conductive indium tin oxide, are the "bread." The "mustard" is two dyes; plastered against one slice is a layer of viologen; against the other, a layer of Prussian blue. A gel electrolyte slathered between the two halves electrically separates the sides, glues them together, and shuttles ions back and forth. Two thin wires curl out from the back and front of the four-by-four-inch device, connecting it to a small direct-current power source.

Leventis hits the power switch, and the tiny window colors to a deep blue in less than five seconds. As the viologen picks up electrons from the negative electrode, it switches from its colorless form to a violet one. The Prussian blue at the opposite electrode simultaneously turns from colorless to blue as it loses electrons. Looking through the dark window is like looking through the sunglasses that skiers use to cut the bright glare of snow. Leventis flicks off the power and the color remains. "These devices have memory. It will stay colored like that for hours without any additional current," he explains. With the power back on he reverses the current, and the window rapidly bleaches back to its untinted state.

The first commercial devices using this kind of switchable glazing are already on the market. Gentex Corp. makes organic-based electrochromic rearview mirrors that

NON-SWITCHED GLAZINGS THAT DO TRICKS

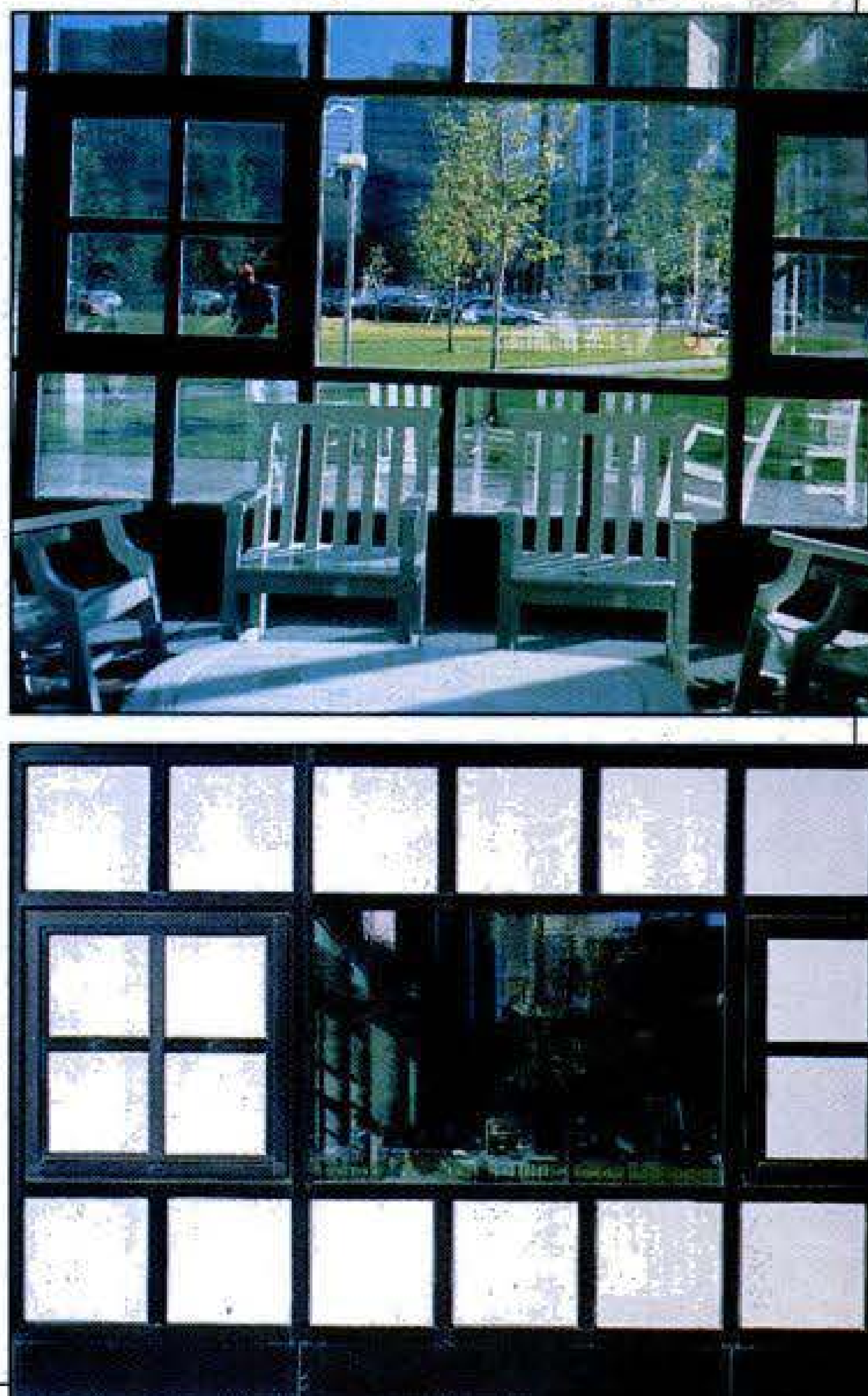
Glazings needn't switch to help windows save energy or provide privacy.

A holographic film designed by Advanced Environmental Research Group in Davis, Calif., for example, can direct a constant beam of light to a specific spot in a room even as the sun moves across the sky. Microscopic grooves laser-etched into a piece of plastic bend incoming light. Aiming sunlight with these thin, passive devices would mesh nicely with electrochromic glazings, says project director Richard Ian-Frese. A strip of holographic film across the top of a switchable window could direct some bright light deep into a room even with the window in its darkened state.

An "angle selective" glazing from Nippon Sheet Glass in Japan also bends light, but in a different way and with a different result. It uses specially tuned diffraction gratings—thin pieces of plastic with millions of invisible slits spaced a fraction of a hairbreadth apart. The distance is two microns, or two thousandths of a millimeter. In one version, light streaming directly into the glass passes straight through, while light entering from angles greater than 20 degrees is scattered. From head on, this glass appears clear; from the side, it looks frosted. With a different diffraction grating, potentially irritating direct sunlight can be diffused into a soft, even light. Now available only in Japan, Angle 21 glass may eventually be sold in the United States.

An intriguing privacy glazing is ContraVision from Cesar Colors in Burlingame, Calif. (see photo). Send the company a logo, photograph, or diorama and it is printed as tiny white and colored dots on one side of a clear plastic film. On the other side black dots line up perfectly with those on the front. The film creates an optical illusion when laminated into a window, which can be as large as four by ten feet.

Stand in front of a ContraVision window and you see just the printed picture; stand behind it and it appears tinted, but clear. "Basically, the black dots carry the eye forward, while the white and colored ones stop it," says ContraVision's president, Claudio Cesar.—*P. J. S.*



With ContraVision's privacy glazing, you can see through one side, but not the other.

automatically darken in response to bright headlights or other glare. The Zeeland, Mich., company is also working on switchable sunroofs and automobile windows. These could lead to architectural windows, says the company's director of electrochemical technology, Harlan Byker. But first, crucial issues like longevity and resistance to ultraviolet light's damaging effects must be solved. "For architectural glass, we need to get at least a 20- or 30-year lifetime," says Byker.

Solid-state devices built from thin films of inorganic electrochromic materials may be the key to sturdy glazings. "Organic materials break down in sunlight. Period. If you want longevity, stick with inorganic compounds," says Ronald Goldner, director of Tufts University's Electro-Optics Technology Center in Medford, Mass. In 1986, Goldner's research team patented Smart Window glass, a switchable five-layer film less than a thousandth of a millimeter thick. It is based on tungsten oxide, which colors from clear to bronze when it picks up an electron and a lithium ion.

Not only will solid-state thin films hold up longer, but they will also be easier to make. Multiple thin films can be deposited onto a glass substrate, conforming perfectly to each other. Pressing a semisolid gel between two electrodes sprayed onto pieces of glass leaves countless microscopic gaps. "On the molecular level, it is like pushing the Rocky Mountains toward the Appalachian Mountains —they just won't meet perfectly," says Goldner.

CLOUDY TO CLEAR

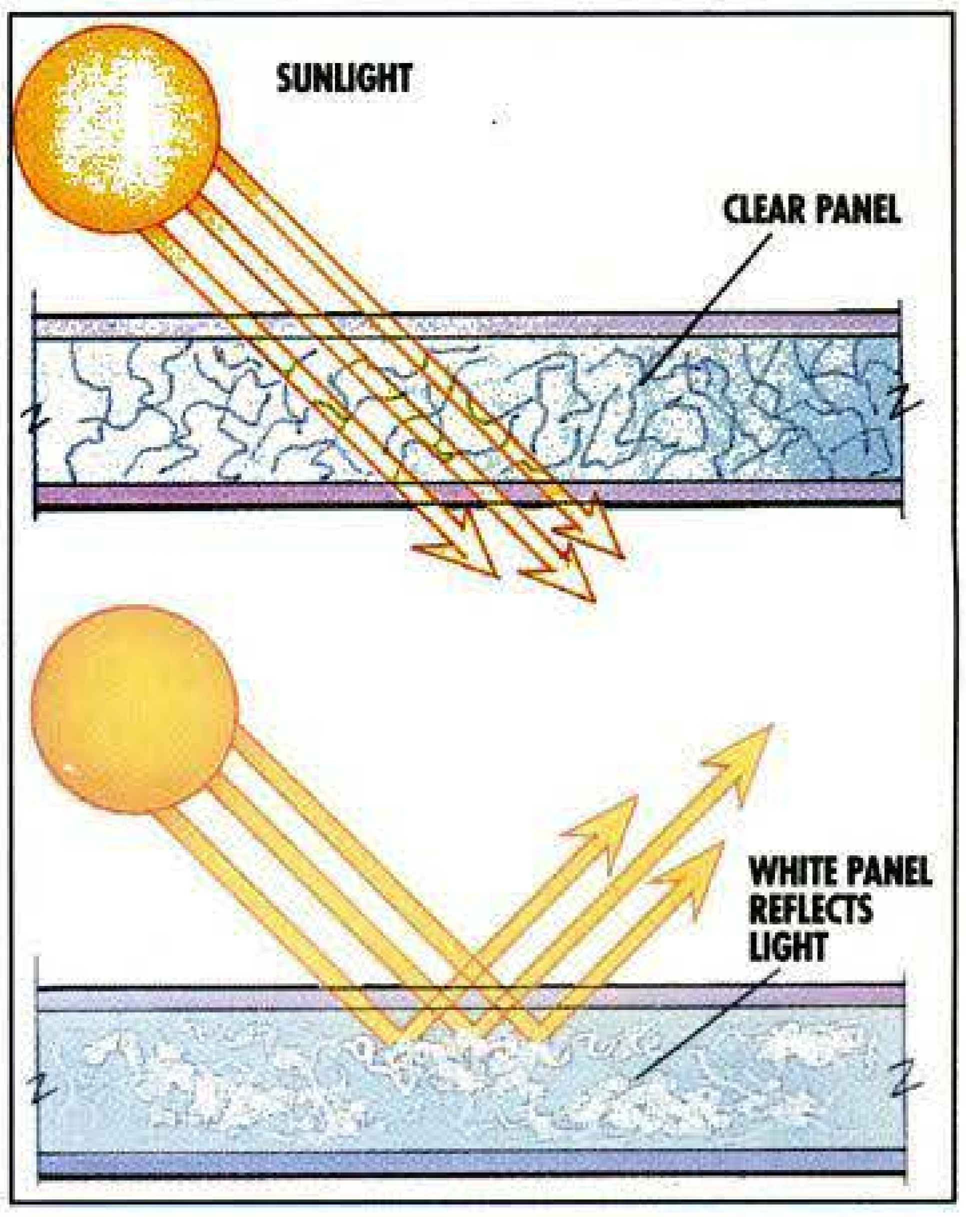
Cloud Gel—dreamed up in 1970 by inventor Day Chahroudi as a companion to his Heat Mirror, the first low-emissivity window coating—finally appears to be ready for commercial production.

This switchable glazing is made from long strands of a special polymer that are mixed with water. The resulting semisolid goo is then pressed between two sheets of plastic. In its "cool" state, the long, vanishingly thin polymer chains spread evenly through the clear mixture, and light zips right past them; in this state, the panel admits 90 percent of incoming light. When you warm up Cloud Gel, however, the polymer clumps into tiny nuggets, turning the panel milky white and blocking up to 90 percent of the incoming light. The system can be tuned to switch over within any two-to-three-degree range between 60°F and 150°F.

Because Cloud Gel switches from clear to cloudy, and does so automatically once it reaches its preset temperature, the technology probably won't be used in view windows. "People want to have control over when and how much a window switches and always want to be able to see out of it," says Carl Lampert, who designs other smart windows at Lawrence Berkeley Laboratory in California.

Instead, Albuquerque, N.M.,-based Suntek plans to use the gel as part of a transparent, highly insulated building panel. On a sunny day, light streaming through a roof or wall built with the company's Weather Panels would gradually warm the building. Once the Cloud Gel hit its critical temperature, however, it would then switch to its opaque state, reflecting most of the sunlight back where it came from while still delivering an even, cool light inside—and saving energy.—*P. J. S.*

Cloud Gel can be "tuned" to change within a two-to-three-degree temperature range to provide energy savings.



Polymer strands clump together to turn Cloud Gel from clear to a heat-reflective cloudy white.

ILLUSTRATIONS BY JANA BRENNING

Taking a lesson from the makers of thin-film photovoltaic modules, researchers at Sage Corp. in Valley Cottage, N.Y., hope to develop a fast, inexpensive way to make thin-film electrochromic glazings by 1994. Company president John Van Dine won't describe the process other than to call it "sequential deposition." He sees two major markets for an electrochromic glazing: new windows and retrofits of the billions of square feet of glass already in homes and offices. Skylights, for example, often deliver light where or when it's not needed. Instead of adding a hard-to-manipulate shade, a remote-controlled glazing powered by a small battery or photovoltaic panel would do the trick, says Van Dine.

Two other electrically controlled glazings—suspended-particle displays and polymer-dispersed liquid-crystal displays—take a different route to switchability. A "light valve," developed by Research Frontiers in Woodbury, N.Y., uses microscopic, needlelike polyiodide crystals suspended in a polymer fluid. This mixture is sealed between two conducting electrodes, much like an electrochromic glazing. With the power turned off, the light-absorbing crystals randomly bounce around and block light from passing through. But turn on an alternating current, and the window's deep blue color begins to fade as the crystals line up "like sharp pencils all pointed straight at the walls," says company founder and chief executive officer Robert Saxe. Unlike electrochromic glazings, constant current is needed to maintain this type of window when it is in its clear state.

Research Frontiers scientists recently encapsulated the crystal/polymer mixture into a plastic film. This eliminates the crystal-settling problems that had plagued the operation of their switchable window. It also makes it easier to laminate the glazing into windows. Switchable sunglasses are another possibility, says Saxe. The company has already licensed its technology to window and flat-panel-display makers.

Liquid crystals can also be used to make a light-valve type of switchable window. Encapsulated in a plastic film between two current-carrying pieces of glass, the tiny crystals normally scatter light, making for a frosted window. Hit the window with electricity and they line up, allowing light to pass through unscattered and turning the glass clear, at least when you're looking straight out. Look to the side, however, and things get a bit hazy. Like the suspended-particle glazings, these liquid crystals also need constant power to stay clear.

First introduced in 1989 by the Taliq Corp. in Sunnyvale, Calif., liquid-crystal windows began popping up in hotel conference rooms, hospitals, and banks. The Church of Scientology installed Taliq's switchable windows in its 27,000-square-foot building in Clearwater, Fla., "mostly for privacy," according to director of construction James Bond. At an

[*Continued on page 87*]

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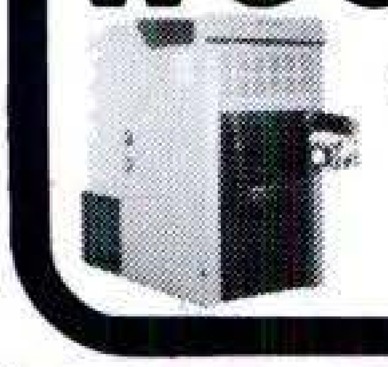

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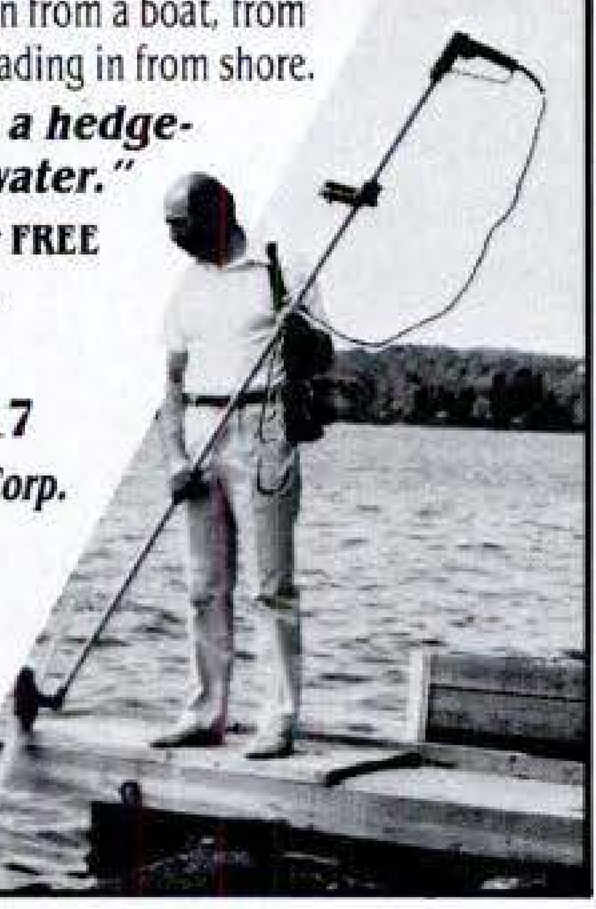

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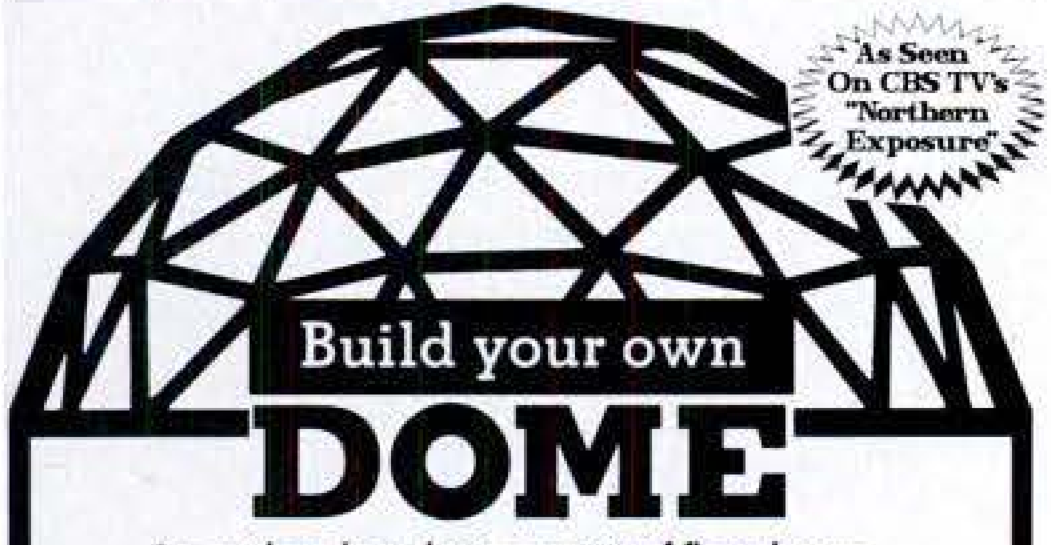
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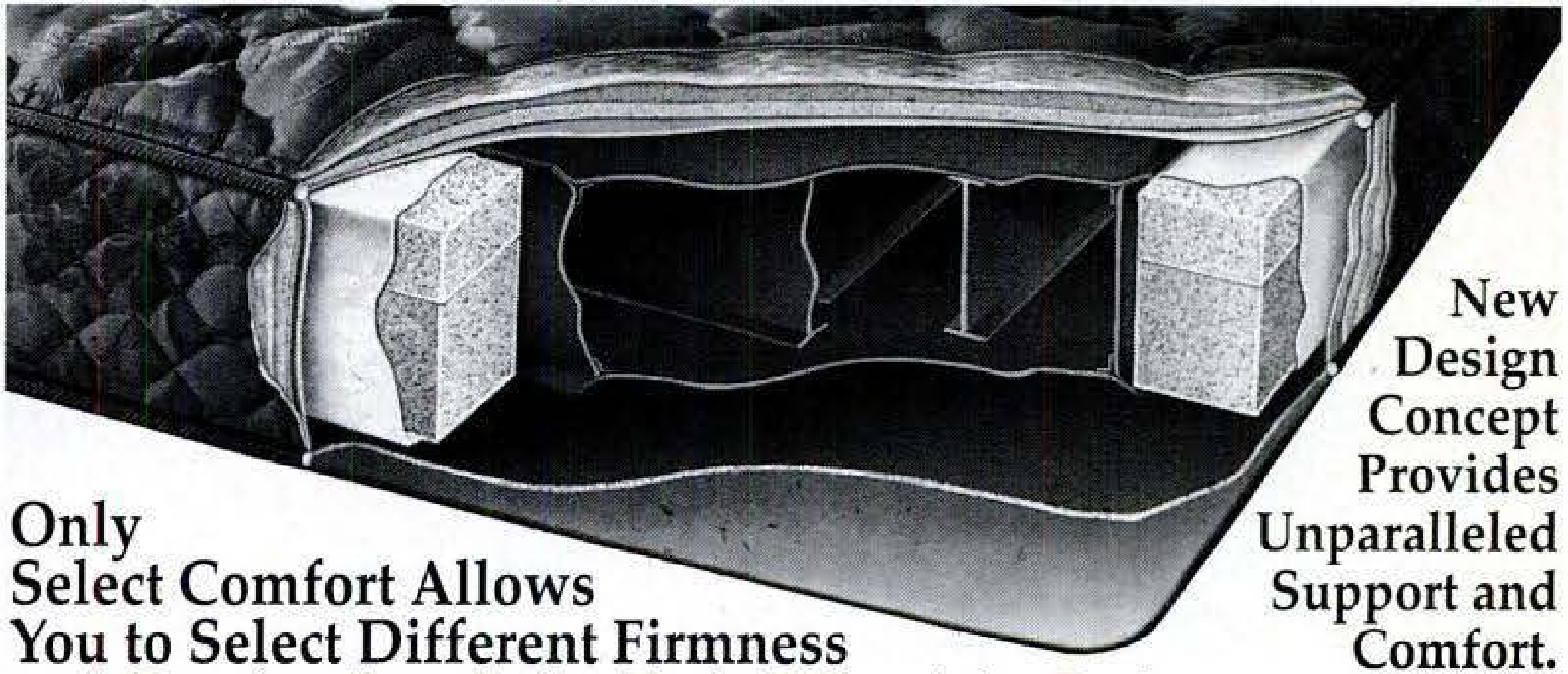

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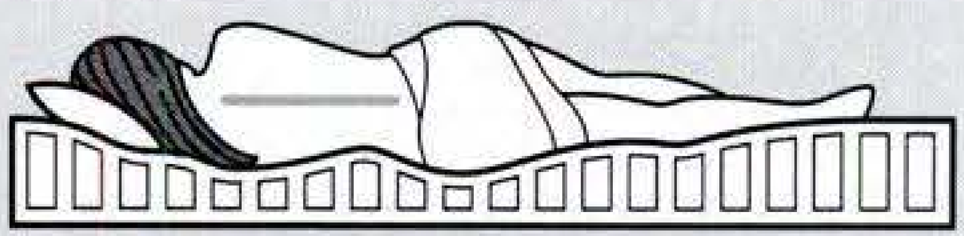

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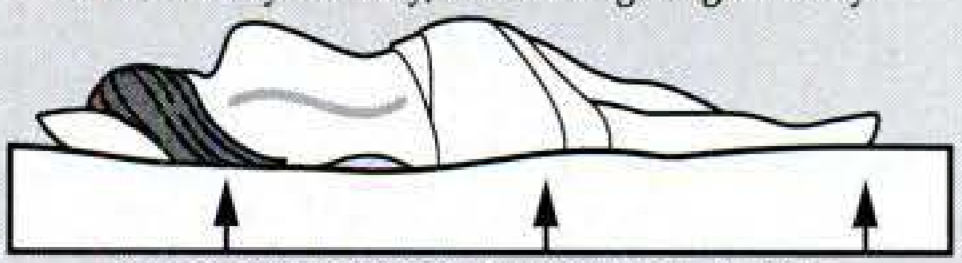

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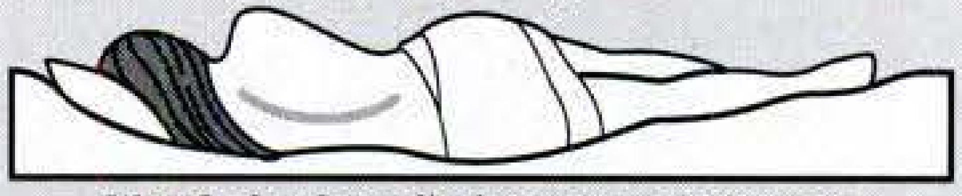

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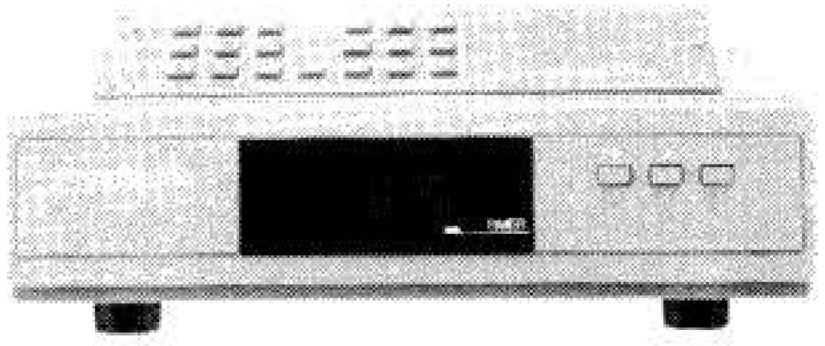

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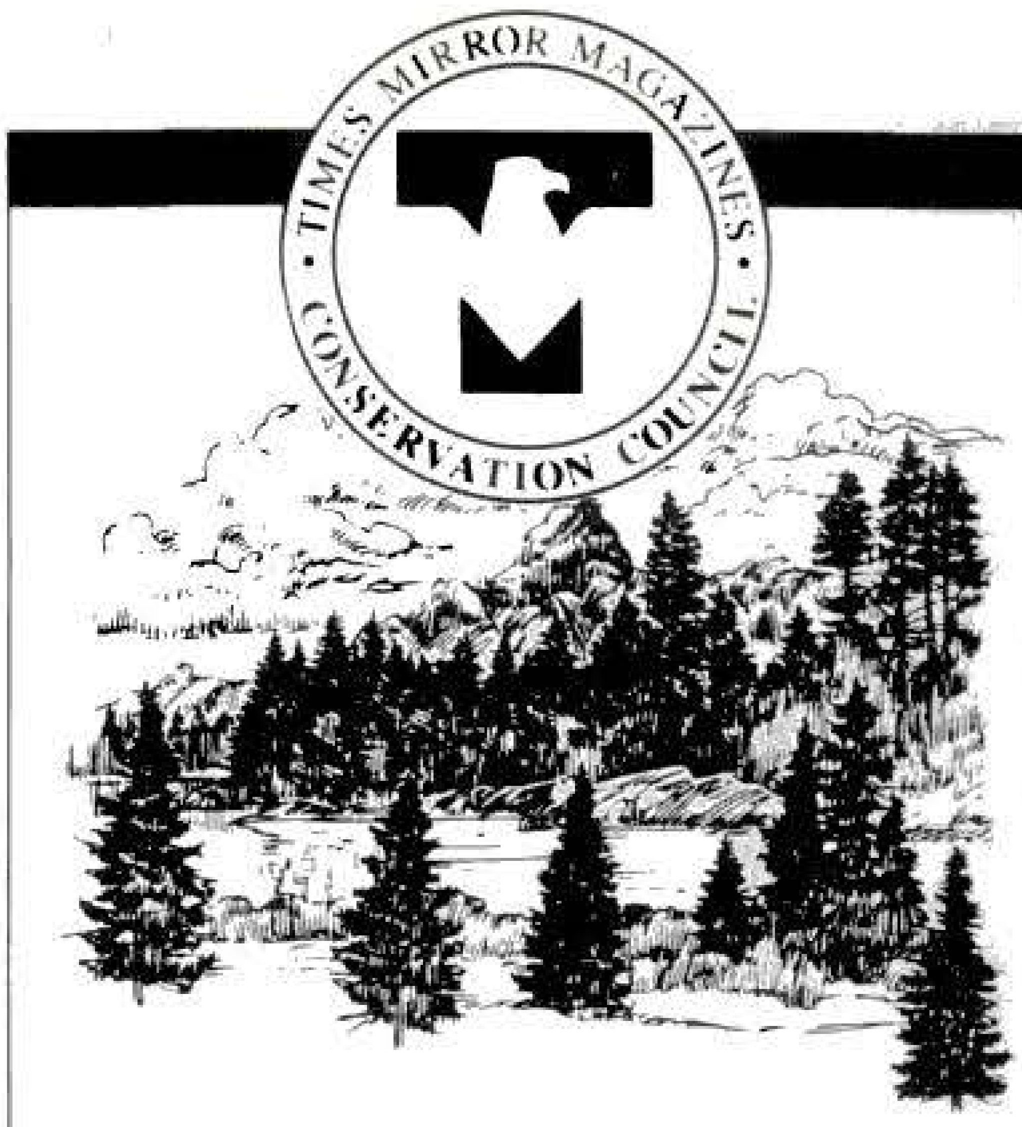

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Window technology

[Continued from page 83]

expensive $100 per square foot, the market for these windows stalled, and Taliq stopped producing them in January 1992.

Musts: last longer, cost less

Despite their promise, switchable windows still need considerable work before they will be able to survive in the marketplace. Durability must be vastly improved—few people are likely to purchase an expensive window that needs to be replaced every ten years. This means creating systems that can switch back and forth hundreds of thousands of times without losing their punch, and that can also withstand a normal window's harsh environment.

More important, the price of a smart window must drop dramatically. Sage's John Van Dine estimates that electrochromic glazings must drop to $8 per square foot before they can penetrate the architectural-window market. An efficient manufacturing process will help reduce costs; so will large orders.

Costs aside, will smart windows appeal to the public? Lawrence Berkeley Laboratory's Selkowitz thinks that electrochromics should be far easier to sell than low-e, or emissivity, windows, which already appear in more than 25 percent of new commercial and residential windows. He calls low-e glazing an "invisible technology" that you just have to trust is working. "With electrochromics, you can see the technology at work and feel its effects right away," Selkowitz adds.

Steven Strong, an architect who specializes in energy-efficient design, has an equally grand vision. "You could make each window individually addressable and controlled by a central computer that responds to heat and light sensors, and even generate the power for switching from photovoltaic modules," says Strong, president of Solar Design Associates in Harvard, Mass.

From there it's just a small step to perfectly transparent, switchable windows that generate enough electricity to power an entire home or office building. See-through, thin-film photovoltaic modules made by Solarex Corp. in Frederick, Md., are already being tested for automobile sunroofs that generate enough juice to run a cooling fan in a parked car. "The real long-term market, though, will be glazings that curtail electricity use in high-rise buildings," says Paul McClusky, Solarex thin films product manager. PS

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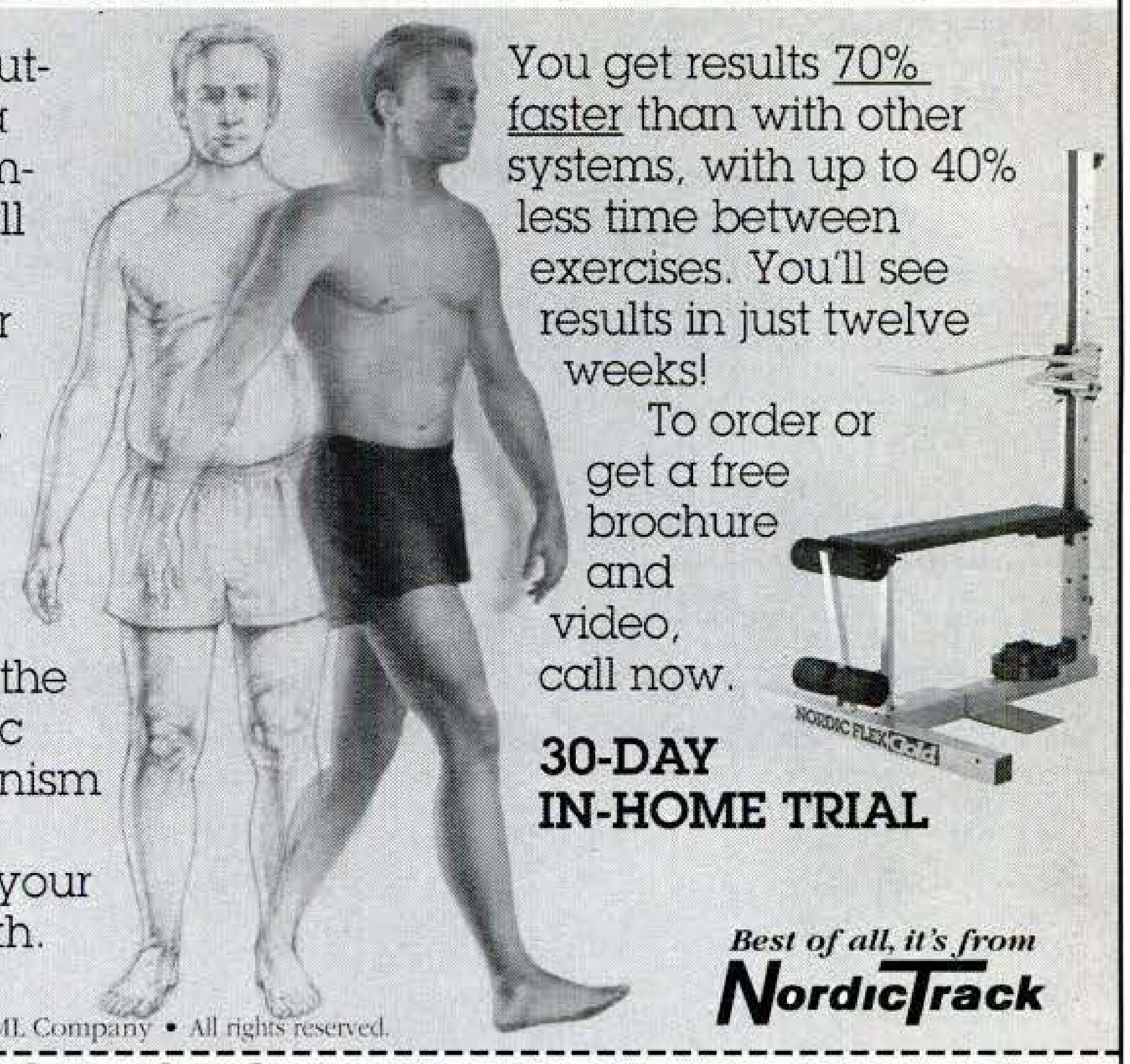

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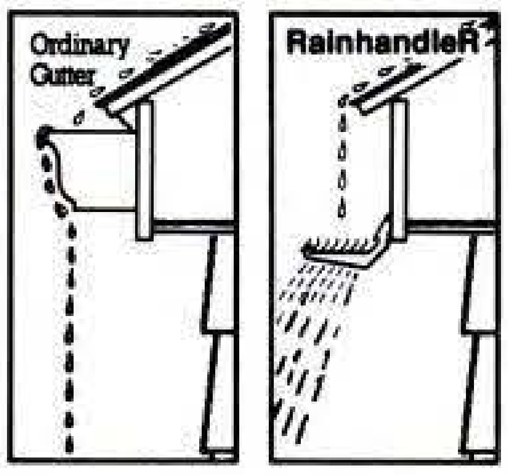

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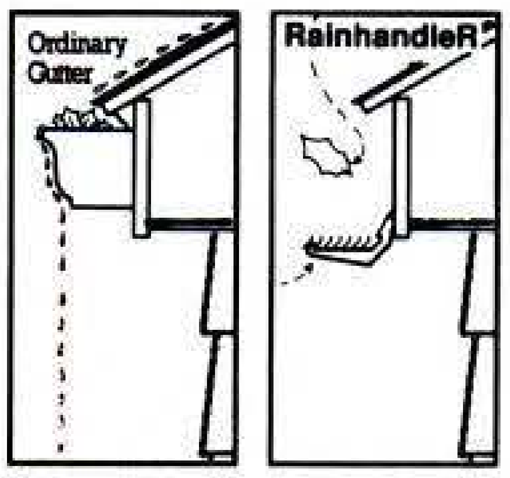

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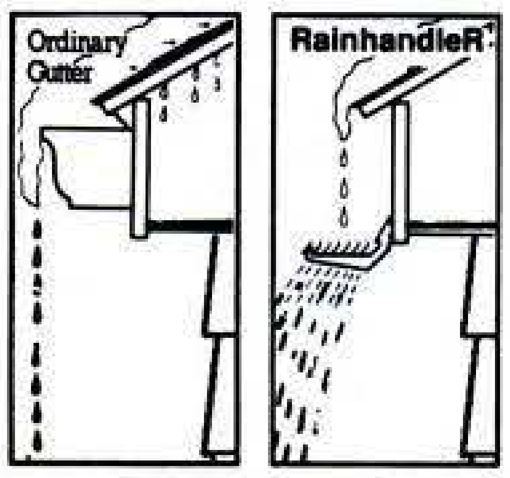

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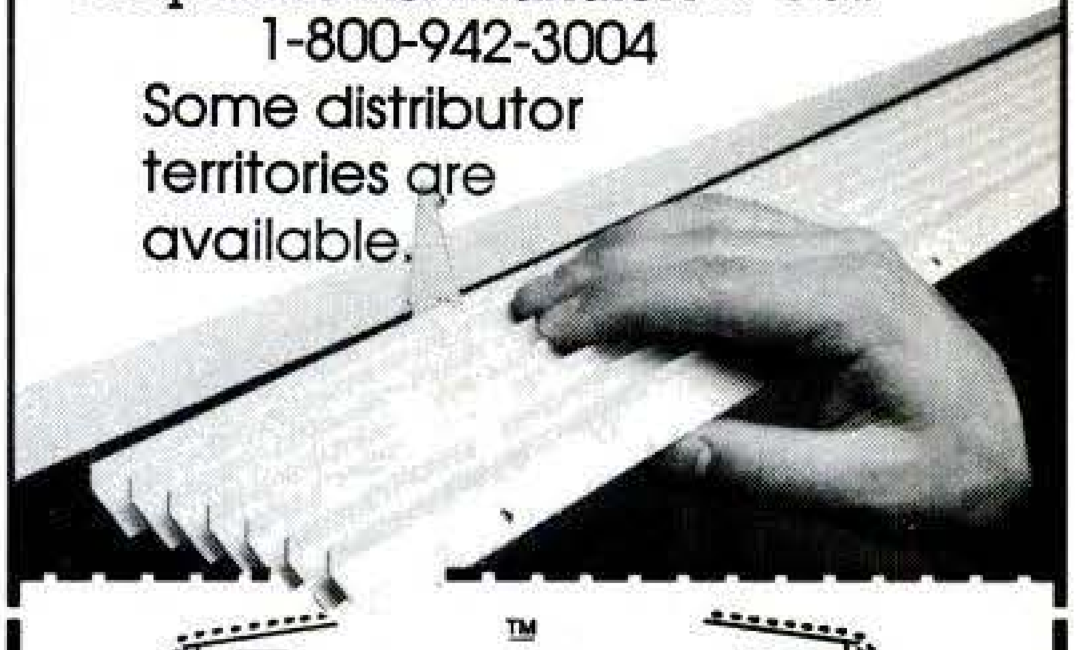

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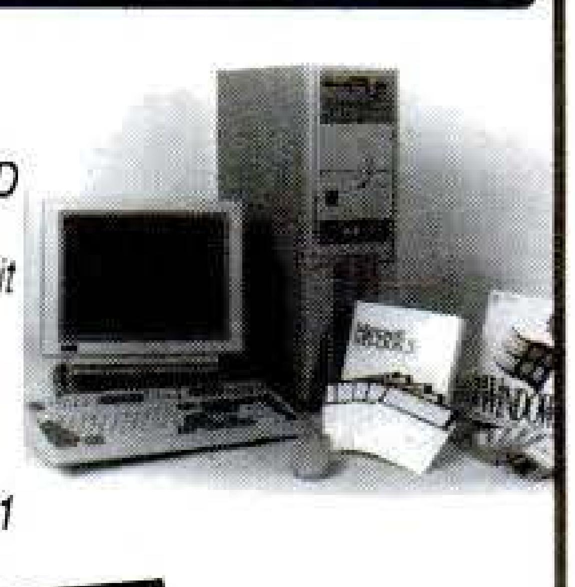

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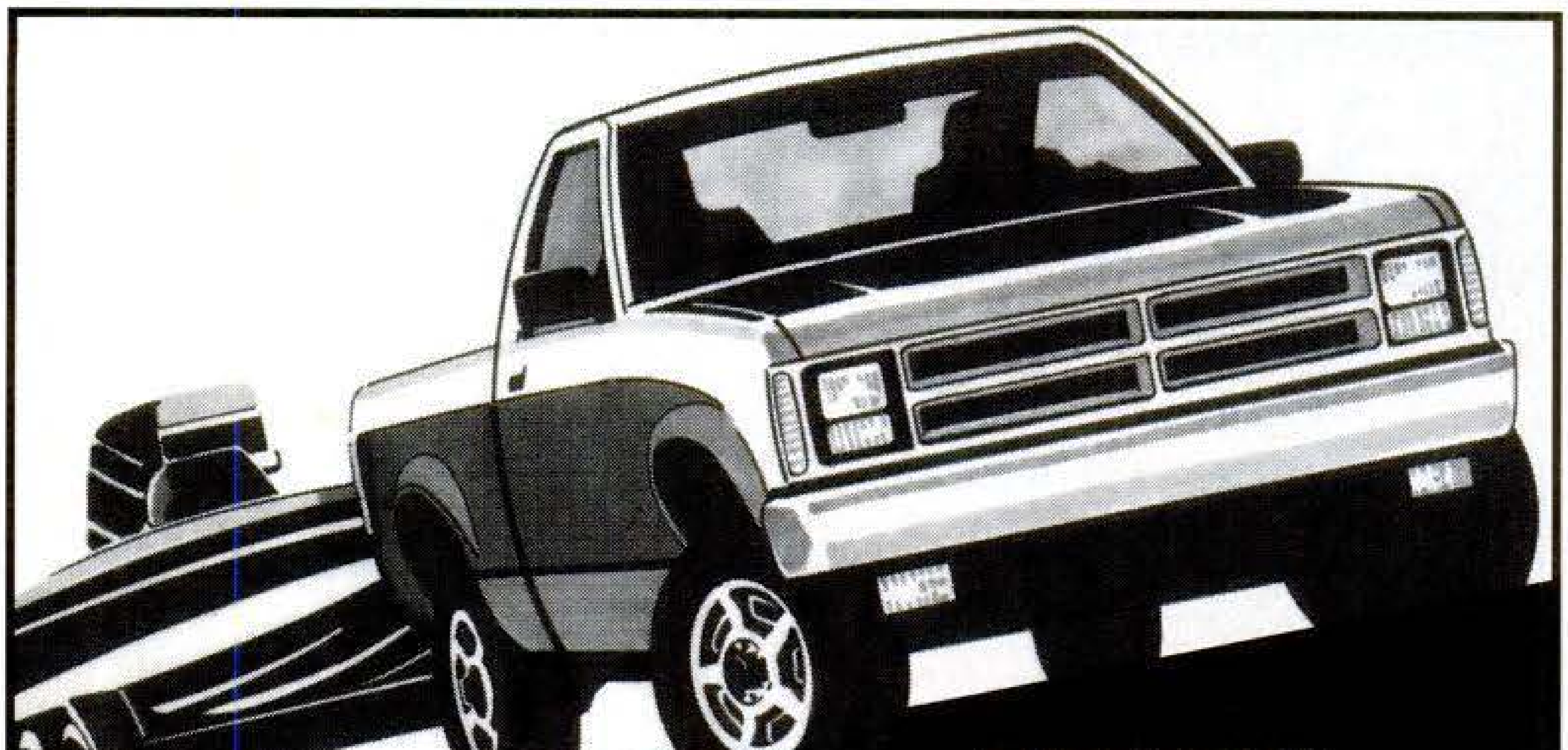

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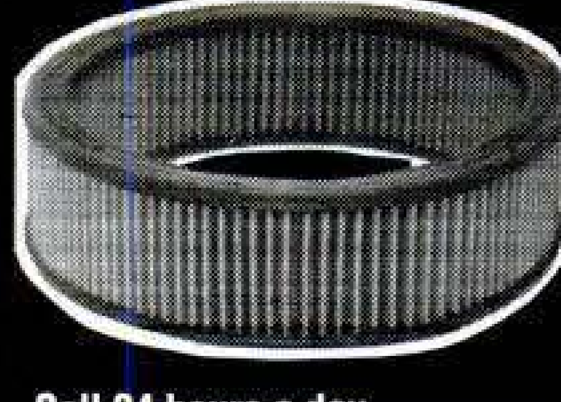

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Power chips

[Continued from page 63]

operating system is ported, or translated, to the chip. Apple is already working on the conversion, but it may be a year or more before it's done. Likewise, it's not clear whether a version of Windows will be ported to the PowerPC.

Opening Windows

Windows *will* be running on at least two RISC microprocessors this year: DEC's Alpha and MIPS's R4000. DEC and Microsoft have collaborated to produce a tailored version of the new Windows NT operating system for the Alpha AXP DECchip 21064 microprocessor, as it's formally known. MIPS, meanwhile, is offering special kits to computer manufacturers that make it easier for them to build systems that use its R4000 and new R4400 chips and run Windows NT.

Both could be very appealing packages. The DEC and MIPS chips are 64-bit microprocessors that are capable of much higher speeds than Pentium, and both companies say they plan to undercut Intel's prices. MIPS, for example, says its kits will enable PC makers to produce Pentium-level machines running Windows NT for as little as $2,500.

Acer America Corp. will be among the first to sell a MIPS-based system, expected later this year. DEC will begin selling its Alpha PCs with Windows NT this year, and it's also licensing its designs to other PC makers, such as Olivetti.

It remains to be seen whether Windows NT truly levels the playing field and makes RISC systems a safe alternative for PC buyers, as many chip makers hope. While Windows NT—which is a complete operating system in itself and doesn't require DOS—will run all Windows programs, it won't run them at top speed unless they've been fine-tuned for a specific RISC chip. That means software publishers may have to develop separate versions of their Windows programs for each RISC processor. Windows NT also requires a great deal more memory and hard disk space than previous versions of Windows, making it difficult to produce the kind of inexpensive PCs that savvy shoppers have come to expect.

Weaving your way through these many choices won't make buying a new PC any easier. Ultimately, though, the new chips on the block seem destined to result in faster, smarter, and splashier PCs for less money. And that's a journey worth taking, even if the road winds a bit along the way. (Next month: the New Operating Systems.) PS

Rescuing an American icon

[*Continued from page 75*]

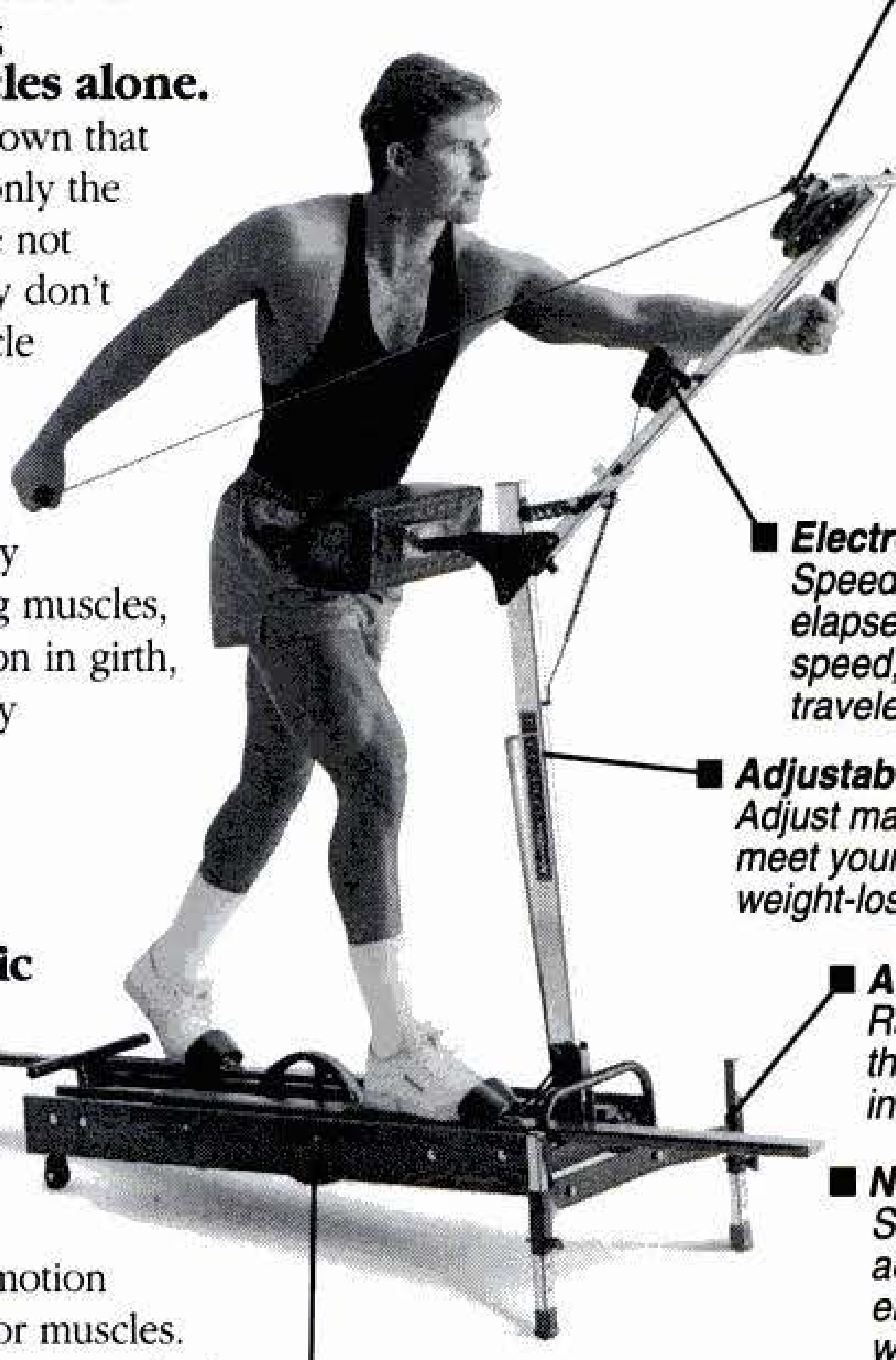
Bartlett plant pathologist. A second option is to combine a trap with a pheromone, a chemical that attracts bark beetles. This can be used to monitor the insect's population, as well as draw it away from the elms. Another idea is a version of sacrificing chess pawns to save the queen and king: Elm trees that are considered low in value—that is, "weed" trees growing along spring banks or those that are not part of a landscape—are killed with a strong herbicide. "The beetles mass-attack the stressed tree for breeding," says Fraedrich. "But the tree dies so quickly that the bark dries out fast." Too fast for the beetles, which can't reproduce successfully in the dead wood because they require a certain level of moisture to maintain their broods.

Challenges that remain

Dutch elm disease isn't the only ailment to worry about. All the work to develop new elms and protect existing ones can be futile, for example, if another disease, elm yellows, appears. "The disease is localized, but where it exists it's a big problem," notes Fraedrich. Some elm hybrids are resistant. But otherwise, the pathogen is unstoppable. Caused by a mycoplasma-like organism, which Fraedrich says is "somewhere between a bacteria and a virus," elm yellows kills the root system. "By the time you see the symptoms," he says, "the tree is dead." Another, cosmetic annoyance: elm leaf beetles, which skeletalize leaves. Traditional American elms can tolerate these insects, but many Dutch-elm-disease-resistant hybrids cannot. Townsend and entomologist Richard Hall at Ohio State University in Columbus are developing leaf-beetle-resistant elms.

In any event, many tree experts remain optimistic about the elm's future. "We're going to have American elms back on the streets, albeit probably not in the numbers that there were before," says Santamour of the National Arboretum. "We want to scatter our eggs a little bit, and make sure they don't all break at the same time," as has happened in years past.

Resistant American elms, hybrids, and new screening techniques will be a boon to the tree's survival, as will the advanced treatments for existing trees. But the final salvation may come from the American elm's natural hardiness and tolerance for abuse. For one thing, points out Fraedrich, the trees reproduce with abandon. "They are prolific even as seedlings." For that reason, among the others, he adds, "there will always be elms." PS



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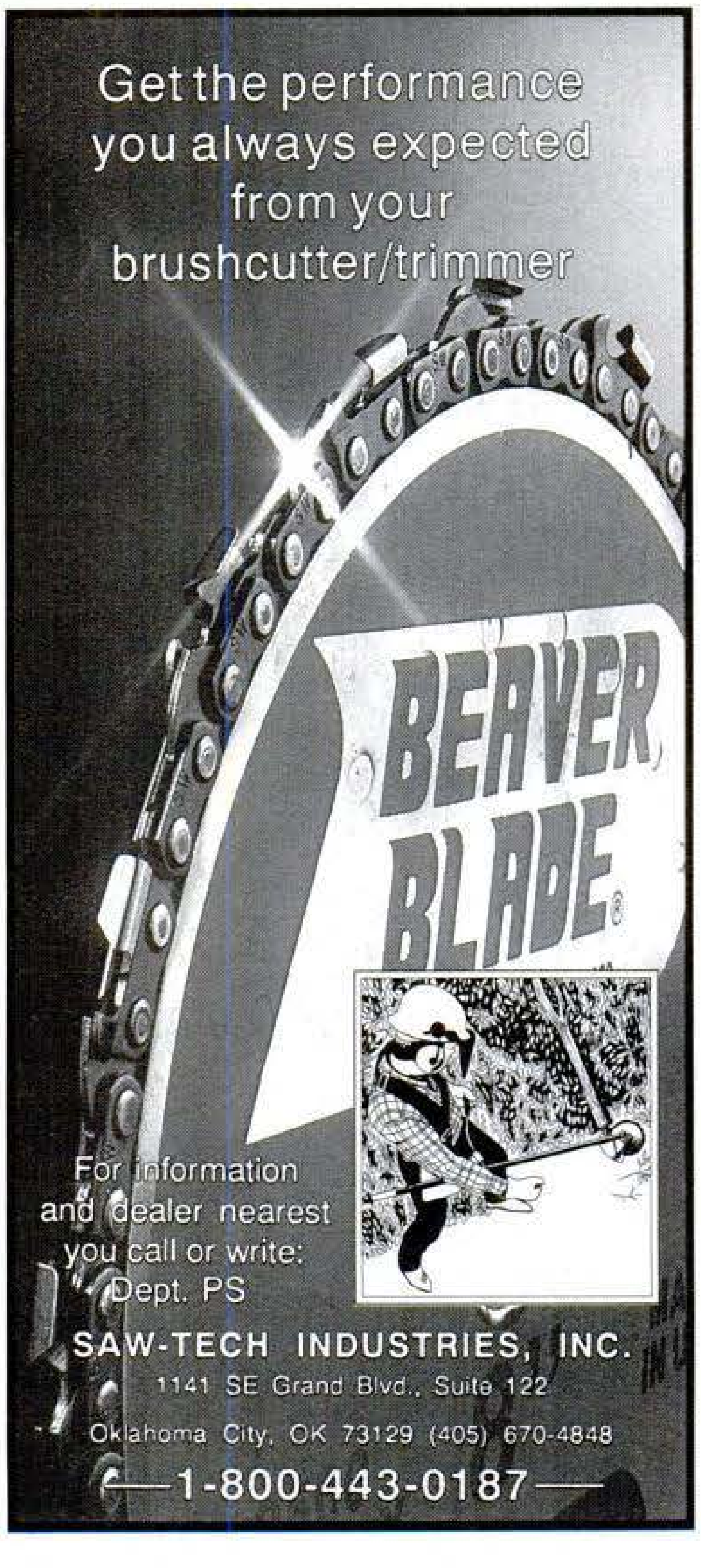
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Chemical weapons

[*Continued from page 71*]

spokesperson for the U.S. Army Chemical Materiel Destruction Agency in Aberdeen, Md. One incinerator burns the liquid chemical agents at 2,700°F; a deactivation furnace with a rotary kiln handles the weapon's explosives and propellants; a third furnace decontaminates metal parts; and a dunnage incinerator destroys packing materials. The salts that remain after incineration are sent to a California hazardous-waste landfill; the Army plans to salvage the metals as scrap.

A burning issue

Although the stack emissions from the facility's four furnaces pass through elaborate "scrubber" and monitoring systems, environmental groups and people living near proposed incinerator sites worry about air pollution: If the chemical agents are incompletely burned, they can release toxic by-products such as dioxin. There is also a possibility that chemical weapons could explode during transport or dismantling. Earlier this year, the Johnston facility had to be closed for a couple of weeks after a fire swept through a containment area where a mustard-gas projectile was being dismantled.

Despite public opposition to incineration, the Army has no backup plan. Congress, however, is holding up funds for the construction of a new incinerator at Anniston Army Depot in Alabama, pending a review of alternatives by an expert panel meeting under the auspices of the National Research Council. Options on the drawing board include:

- *Supercritical water oxidation.* Dissolved in supercritical water (water under extreme heat and pressure), chemical agents are oxidized by oxygen introduced from air.
- *Steam gasification.* Chemicals treated with steam at about 1,800°F to 2,400°F break down into simpler molecules of carbon dioxide, carbon monoxide, and hydrogen.
- *Plasma arc pyrolysis.* A thermal plasma field, created by passing an electric current through a low-pressure airstream, atomizes chemicals. The elements recombine into hydrogen, carbon monoxide, and hydrochloric acid.

A June 1992 report from the congressional Office of Technology Assessment suggested that none of these alternatives would be ready in time to meet disposal deadlines, however. Also, says Tischbin, there's no way to do away with incineration entirely. "We may be able to replace the liquid incinerator, [but the options are] very questionable in terms of explosive disposal, and we don't know of any other technology that would handle the metal parts," she adds.

The Army hopes to eliminate the risky disassembly process by combining incineration with cryofracture. In this technology, now undergoing pilot testing, an entire weapon is immersed in a frigid cryogenic nitrogen bath, which makes it brittle, and then is fractured with a hydraulic press; the fragments are incinerated in a single rotary kiln. A National Research Council panel that studied large-scale cryofracture in 1991 warned, however, that the technology may not be ready for many years, and it "is not especially useful in the disposal of bulk agent or in the disposal of munitions such as rockets, whose aluminum [or copper] shells, rather than growing brittle at lower temperatures, actually become tougher."

40,000 tons of trouble

In Russia, which has also agreed to destroy its chemical arms within a decade, expensive incineration may not be the answer. In 1990, the Soviets unveiled a chemical-neutralization plant near Chapayevsk in the Ural Mountains, 500 miles southeast of Moscow. The resulting public outcry led to the closing of the plant, which was the only facility that the country had built for destroying chemical weapons.

In January, the United States, Russia, and more than 100 other nations met to support a treaty that aims to destroy all chemical weapons by 2005. This treaty would cover new "binary" weapons as well as the 25,000 metric tons of old "unitary" agents in the U.S. stockpiles. Unitary agents are directly toxic to humans; binary weapons contain two chemical components that are relatively nontoxic until mixed.

To become international law, the treaty must be ratified by at least 65 nations—the goal for that is 1995. The nations would then have a decade to destroy the arms. A country could get a five-year extension if needed for technical reasons. Russia, many believe, will have to apply for the extension.

Getting rid of old chemical weapons is proving so difficult, in fact, that desperate Russian scientists have entertained a daring idea. Financially strapped by the fall of communism and saddled with 40,000 metric tons of chemical munitions inherited from the former Soviet Union, Russia has considered killing two birds with one large stone: destroying the entire chemical stockpile with underground nuclear explosions.

The extrasensory car

[*Continued from page 79*]

latter system has been slowly evolving from various on-board navigation systems tested by GM and others.

The accuracy of these systems is impressive, and most of the development work now is focusing on conveying the information to the driver. The Telepath van uses a HUD combined with verbal commands. A mechanical-sounding voice directs the driver to "turn left at the next intersection," while a simplified arrow points the way on the HUD. Early warnings are provided by notices such as "0.2 miles to intersection," while on occasion the whole display is dominated by short-lived alerts like "flood warnings." The setup is as clear as any navigation display I have encountered.

Studying the driver

GM's latest HUD resulted from studies that determined exactly where the driver is looking at any point in time. Perceptual studies that seek to develop an easily comprehended visual display are based on research that studies eye motions to clock exactly how often a driver's eyes stray from the road. The technique involves an array of tiny video cameras, coupled to a laser beam that reflects from the cornea and can measure exactly where the eye is facing.

Aside from its use in research, the eye-motion detector is one of a series of tools used in biomechanical research that can directly monitor the physical well-being of the driver. Some eventually could be miniaturized and used to actively control the car.

One such system is a pressure-sensing mat that originally was developed to measure seating comfort by detecting any areas of the body getting undue pressure that could cut off the blood supply. Automotive seat supplier Lear Siegler is working on a sensor that automatically adjusts a driver's seat as soon as he sits down. Toyota has demonstrated an air-conditioner control that monitors body temperature directly, rather than waiting for a driver to decide if he is too hot or too cold.

The neural approach

A second generation of sensors used to measure seating comfort in the lab actually monitors electrical impulses generated by tense muscles. So far, this has not been incorporated into a self-adjusting seat. But Nissan researchers have gone so far as to suggest that remote-monitoring electroencephalograms could potentially tell whether the driver is dozing off—a particular problem on traffic-jammed Japanese highways. The eye-motion detector has similar potential; if you're not blinking, you may be asleep.

Ultimately, biomechanical sensors could give the car itself a rudimentary neural system, coddling the driver, making him comfortable, or giving him a poke in the ribs if he gets out of line or starts to doze off. That's a long way from the sense of control that comes from cranking up an inanimate block of steel in the morning and making it do your bidding. The notion of a car with extrasensory abilities could be in conflict with the common pleasures of driving, if not an outright invasion of privacy.

Still, the potential safety benefits are difficult to ignore, and sometime in the next decade, on-board electronics that expand the senses may become as common as the rearview mirror. PS

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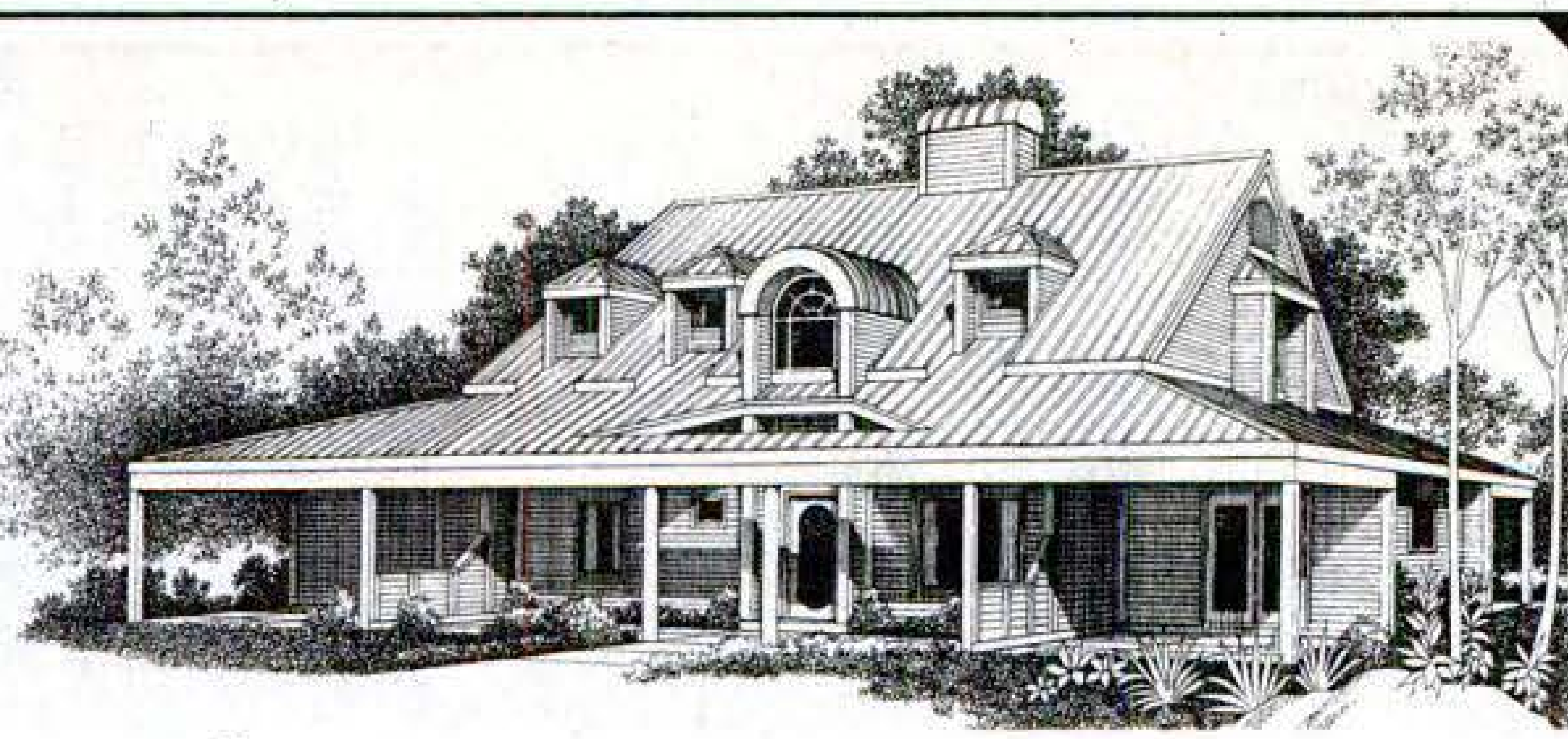

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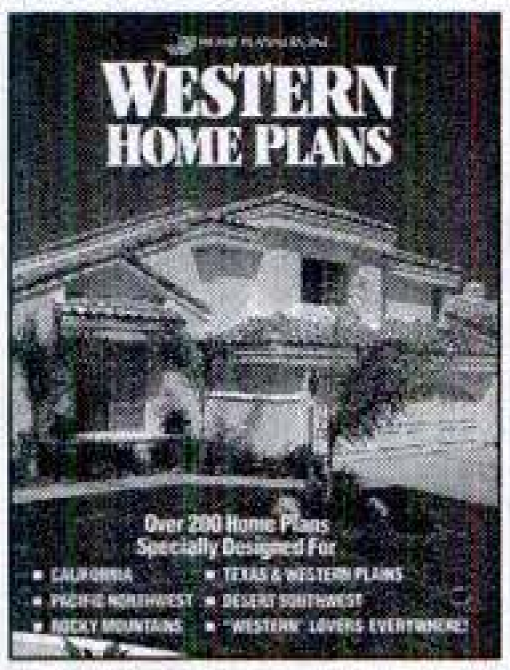

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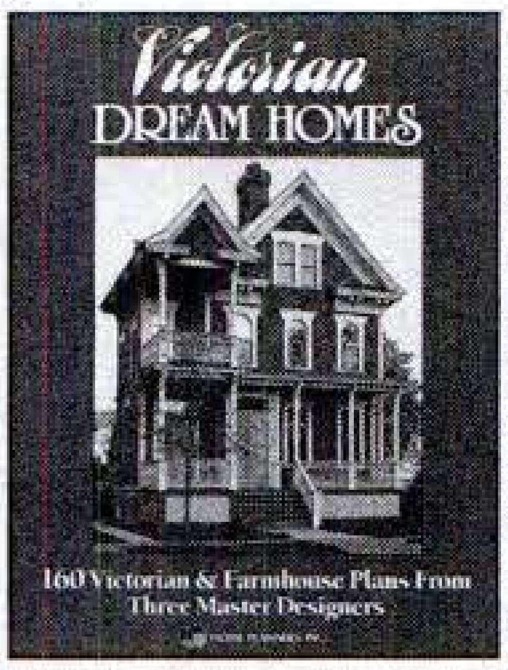

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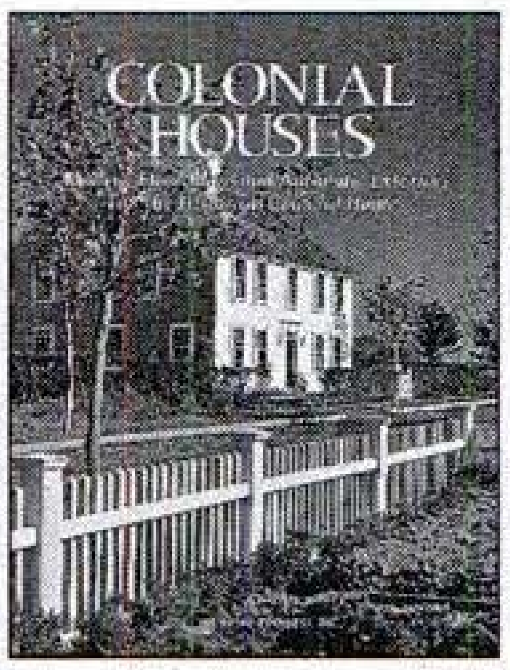

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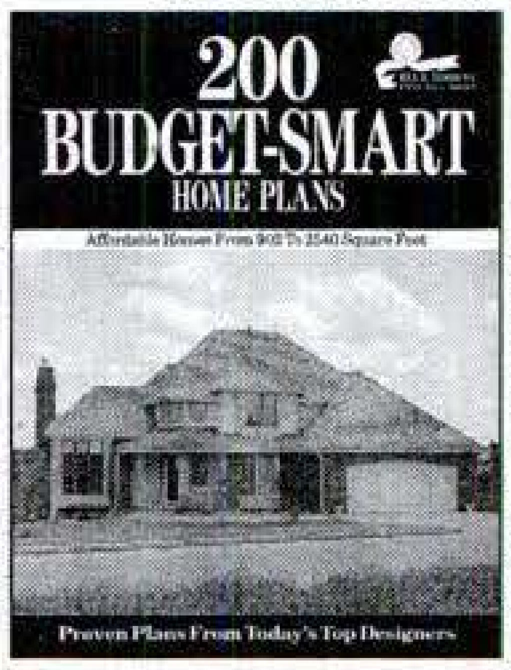
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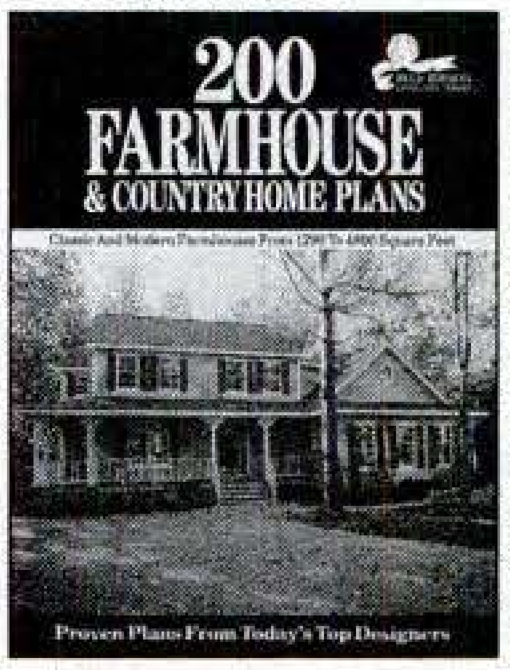
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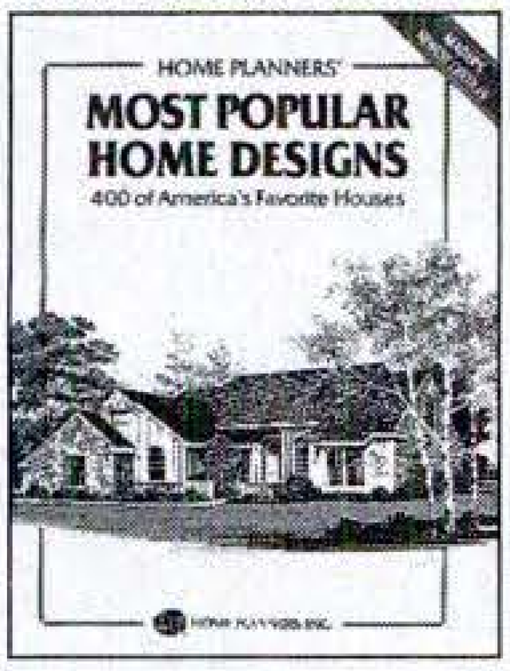
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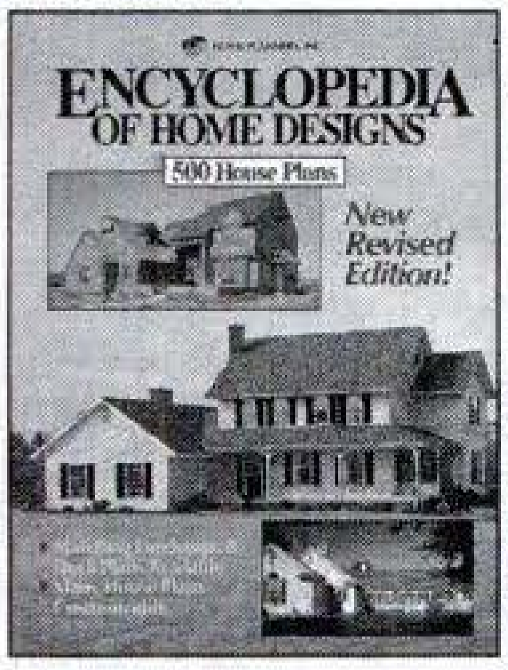

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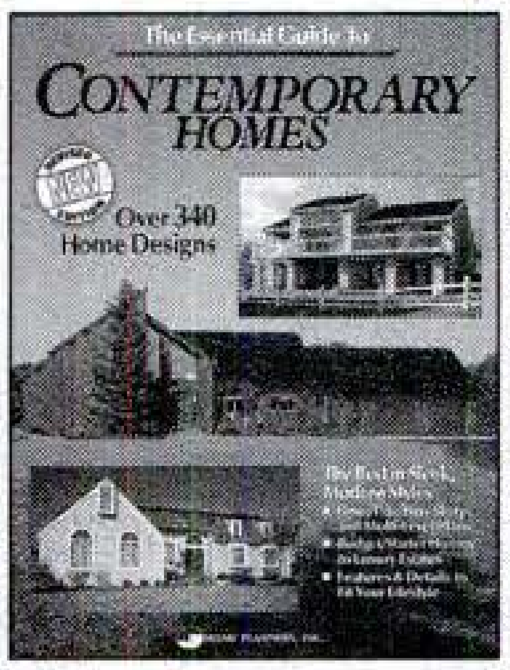

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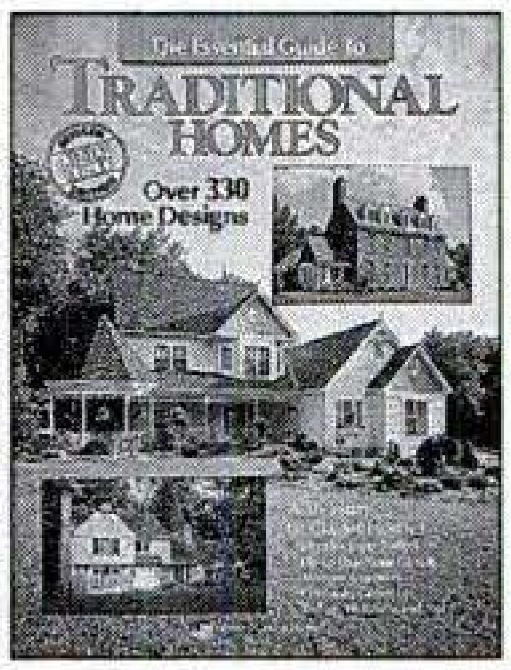

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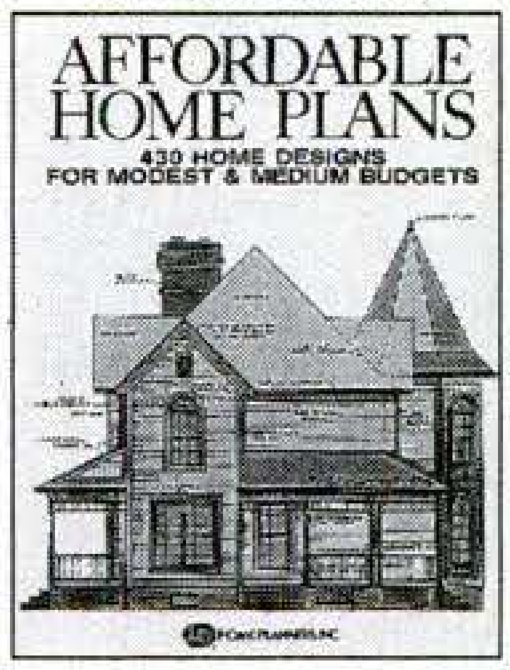

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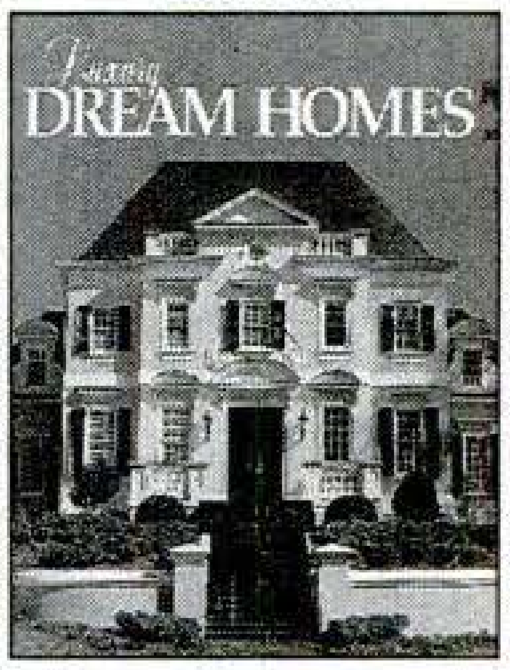

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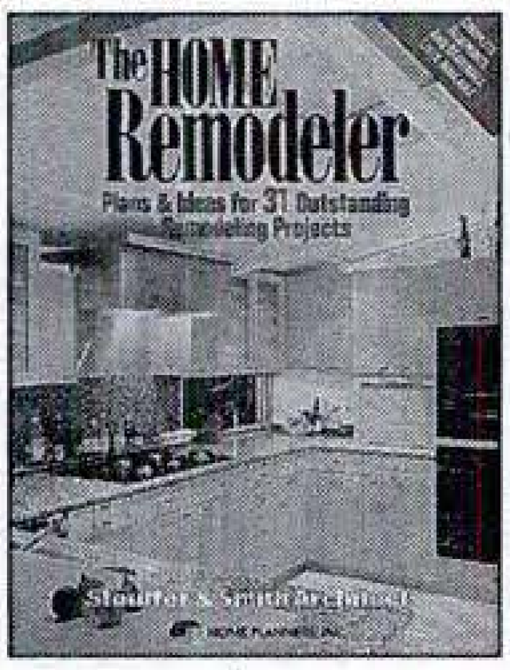

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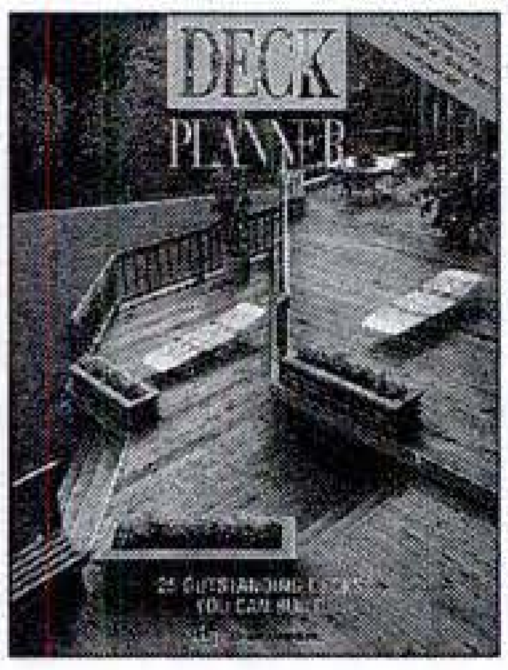

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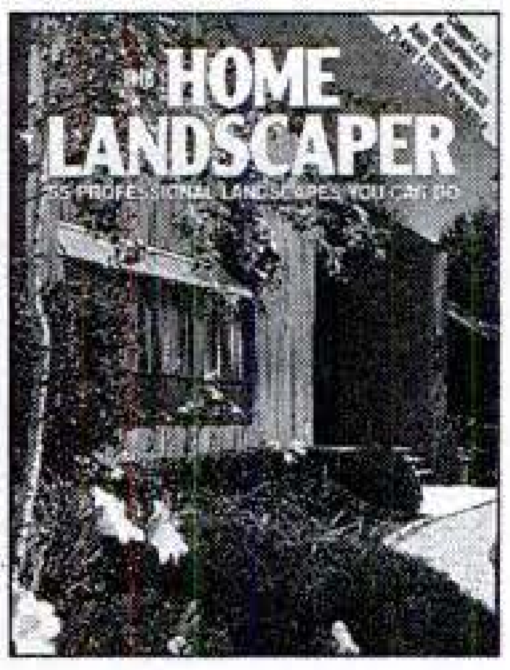

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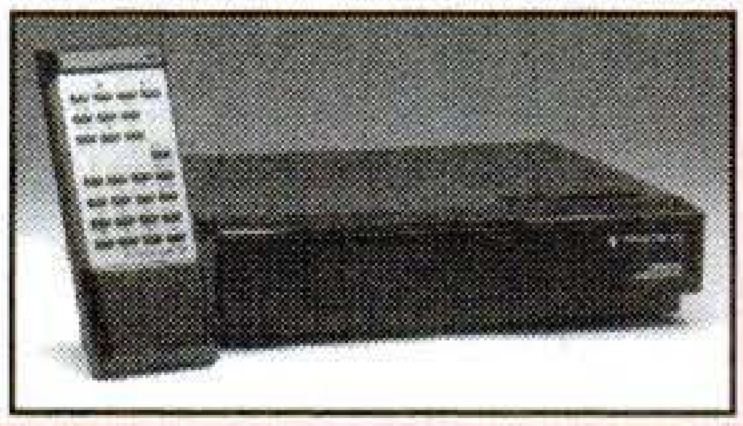

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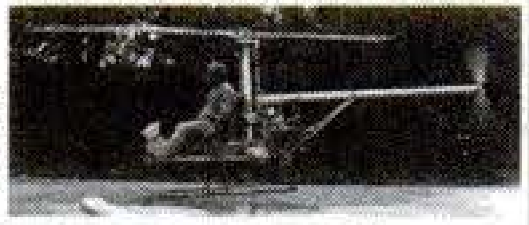

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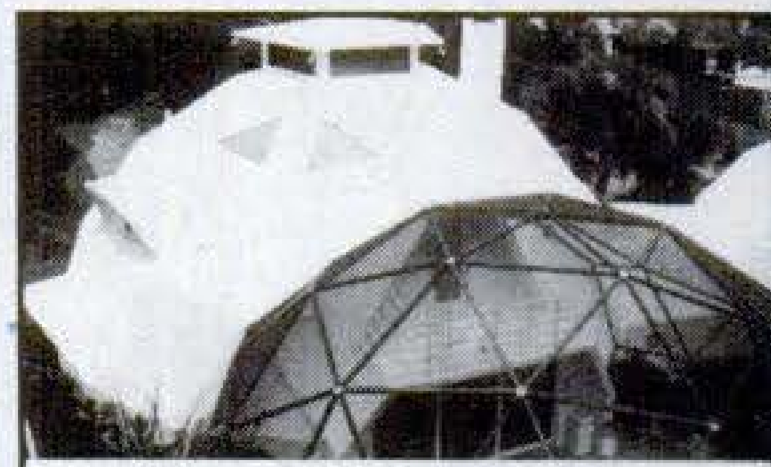

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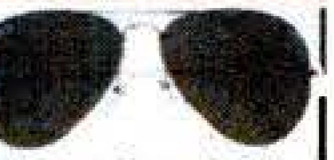

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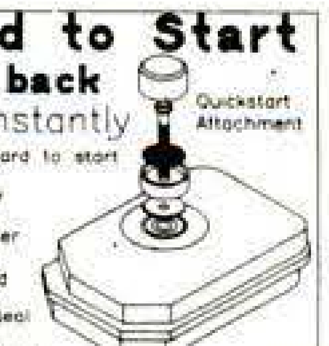

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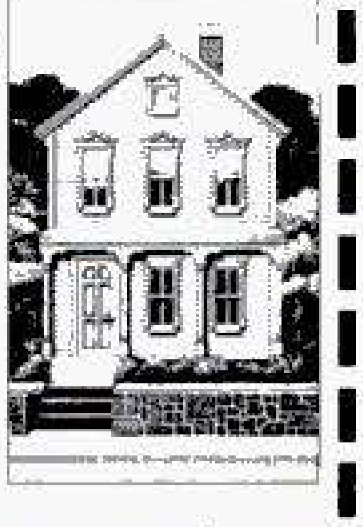

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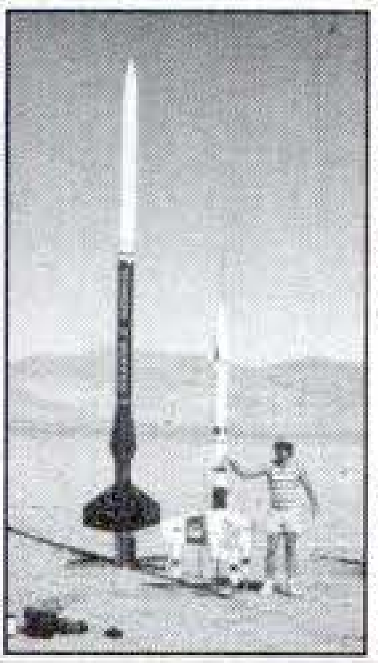

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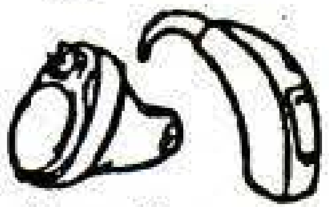

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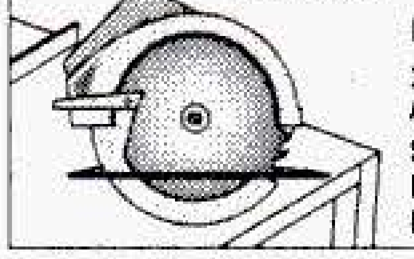

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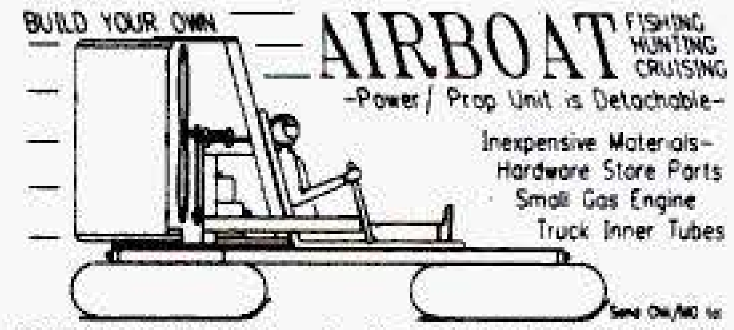

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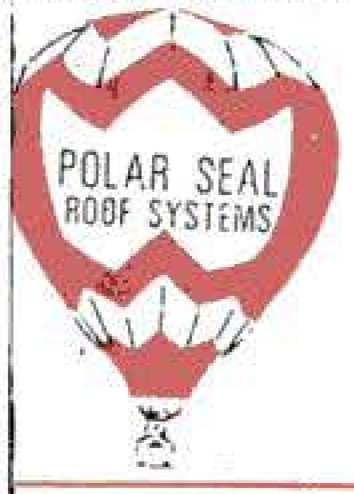

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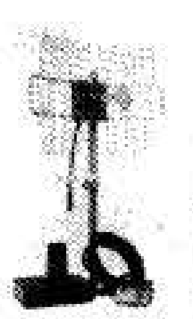

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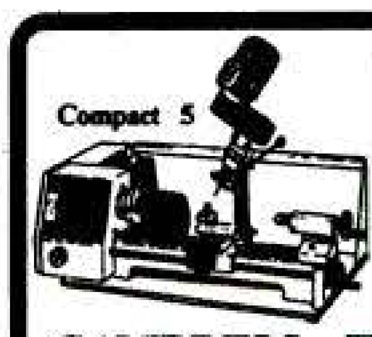

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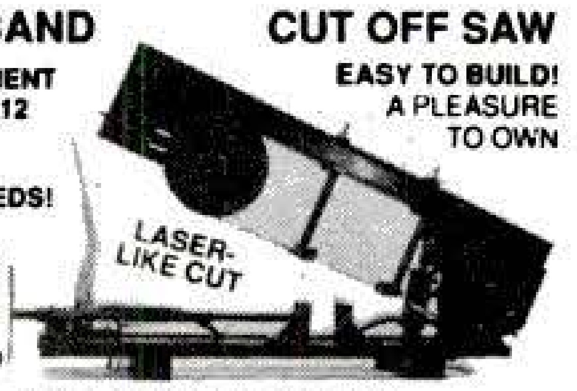

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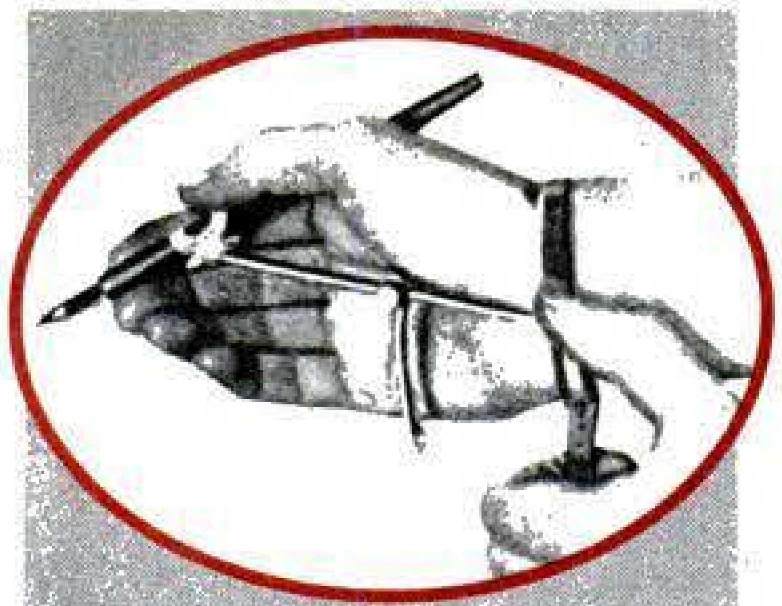


75 Years Ago

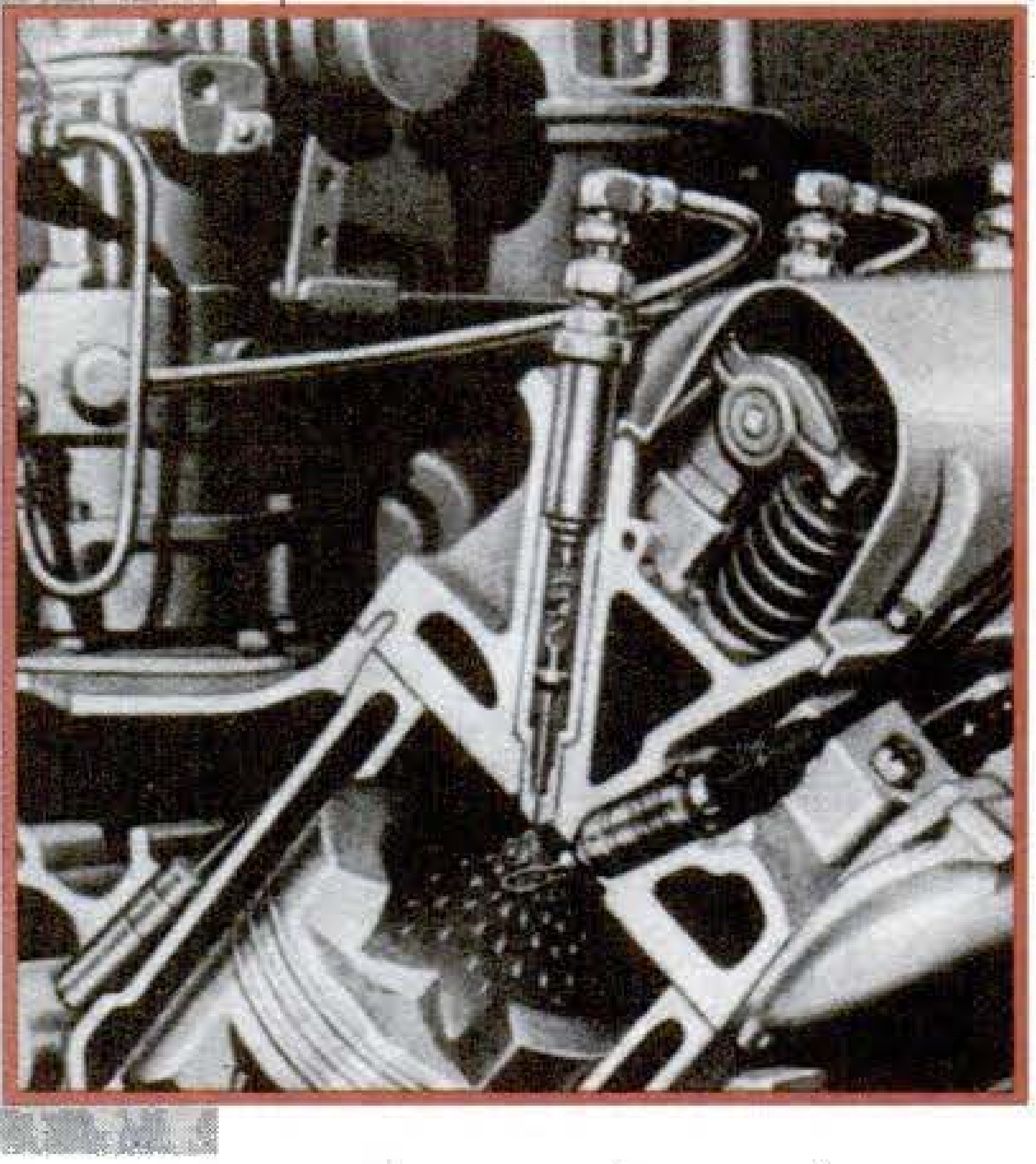
Perfect Pencil Posture

Children strapped on this device to grip a pen or pencil properly. The pen was held in a clamp attached to an adjustable metal tube running perpendicular to the wrist strap. The device never achieved widespread use in schools. *—July 1918*

25 Years Ago

Forever Leaner

Ford's stratified charge engine was the first stage in developing lean-burn technology, promising lower emissions and better fuel mileage. In the late '70s, Ford planned to introduce the programmable combustion lean-burn engine, but decided against it because the engine didn't meet the new California emissions standard. Today, the problem of complying with nox standards keeps it in the labs.*—July 1968*



25 Years Ago

Cross Country By Car

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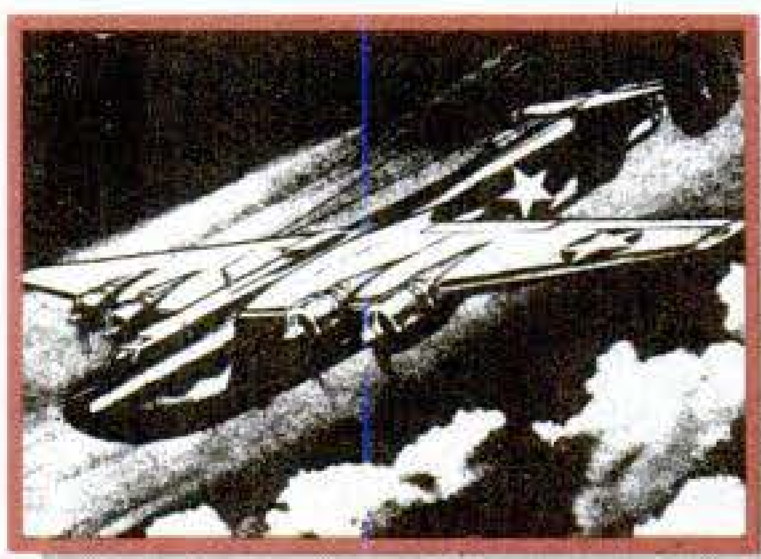


50 Years Ago

On Target

Precision bombing during World War II meant the ability to see the target using an "automatic" bombsight said to be 70 percent accurate at 35,000 feet. Laser-guided bombs, today's precision weapons, were first successfully used in the Vietnam War, and more recently with devastating effectiveness in Desert Storm.*—July 1943*

50 Years Ago

Tank Killer

Nicknamed the Bazooka, the M9 for paratroopers and the M1 for the infantry were the newest rocket launchers. They were replaced by larger models —still called Bazookas—in the Korean War. By the time of the Vietnam War, the Bazooka had been replaced by the 90mm recoilless rifle.*—July 1943*

100 Years Ago

Shooting The Moon

With the beginning of telephotography came "clear pictures of objects that are at such a distance from the photographer that ordinary photographic equipment is useless." The device consisted of a telescope, camera, and special lenses to obtain a clear image. Over time, little has changed. Although cameras with lenses powerful enough to probe the stars, planets, and other heavenly bodies are now available, most photographers still prefer to use the "old fashioned" method. *—July 1893*

75 Years Ago

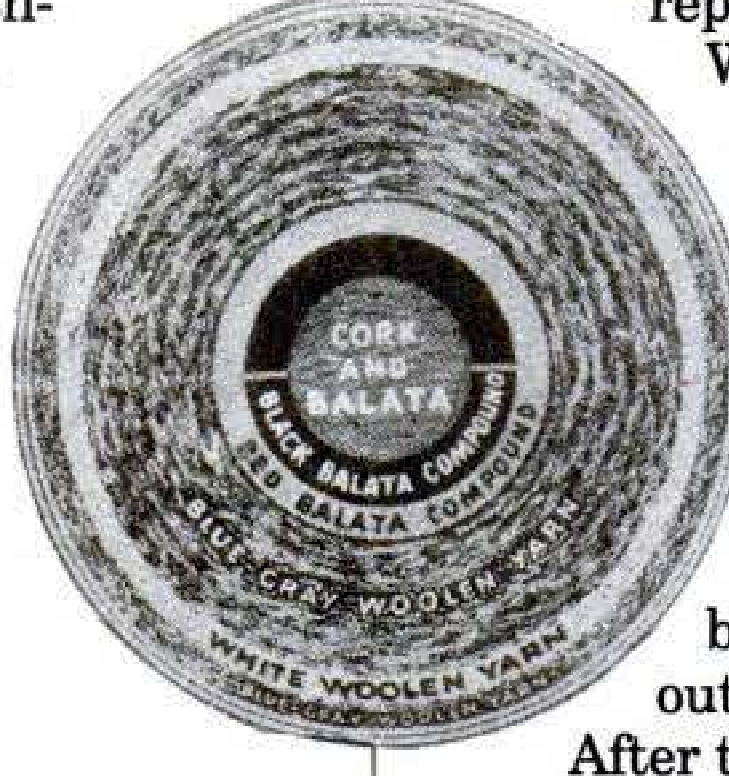
Tire Time Tracks

The prediction that the truck may become a competitor of the railroads is based on the fact that the pneumatic tire takes away the speed limitations imposed by the solid rubber ones." The tradeoff, of course, was flat tires. With the development of run-flat pneumatic tires, new high-performance tires now offer the advantage of solid rubber tires. *—July 1918*

50 Years Ago

Bounceless Baseballs

With rubber on the critical-materials list in World War II, Spalding turned to balata as a replacement. Without the flexibility of the rubber core, however, the first balata balls were so "dead" that batters could barely hit them out of the infield. After the war, Spalding and the major leagues returned to rubber-core baseballs.*—July 1943*



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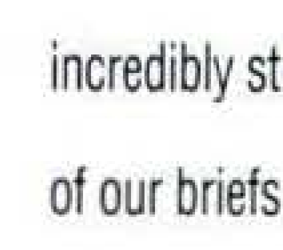

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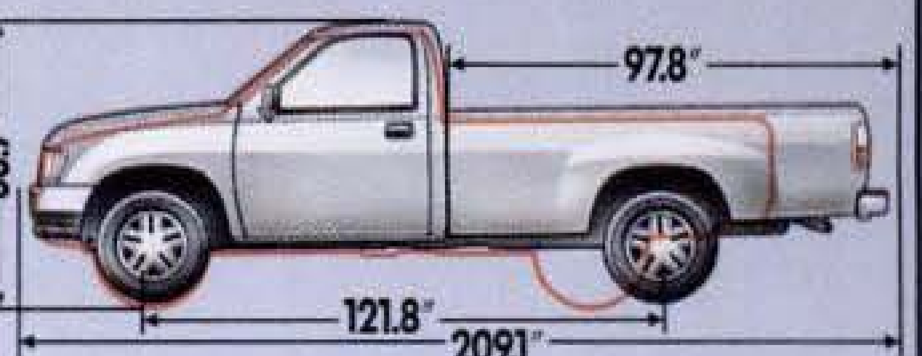

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*Includes occupants, equipment and cargo for One-Ton model with 5-speed manual.

**Not to exceed GCWR of 9,000 lbs. Requires additional 500 lb. weight carrying frame-mounted Class III tow hitch.

Buckle Up! Do it for those who love you.

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